THE FRODSHAMS

THE STORY OF A FAMILY OF

Chronometer Makers

VAUDREY MERCER

The Frodshams
The story of a family of Chronometer Makers
1758 - 1980

Having written the stories of the Arnolds and the Dents it was only necessary for the author to write the story of the Frodshams to complete the trilogy concerning these three partly interwoven great chronometer making firms. This volume fulfils that need.

Charles Frodsham, whose portrait is on the dust jacket, was fortunate enough to be able to acquire the premises and the goodwill of John Roger Arnold's business at 84 Strand, and, in spite of, or perhaps because of, the proximity of Edward John Dent at 82 Strand, he was able to maintain the high standard set by the Arnolds. His marine chronometers and his exceptionally fine watches soon made the name of Charles Frodsham famous.

His father, William James Frodsham, had become the partner of William Parkinson and the firm of Parkinson and Frodsham had become renowned for the excellence of their marine and pocket chronometers. The story of the use of these chronometers on board the ships sent to try to find a North West Passage is fascinating.

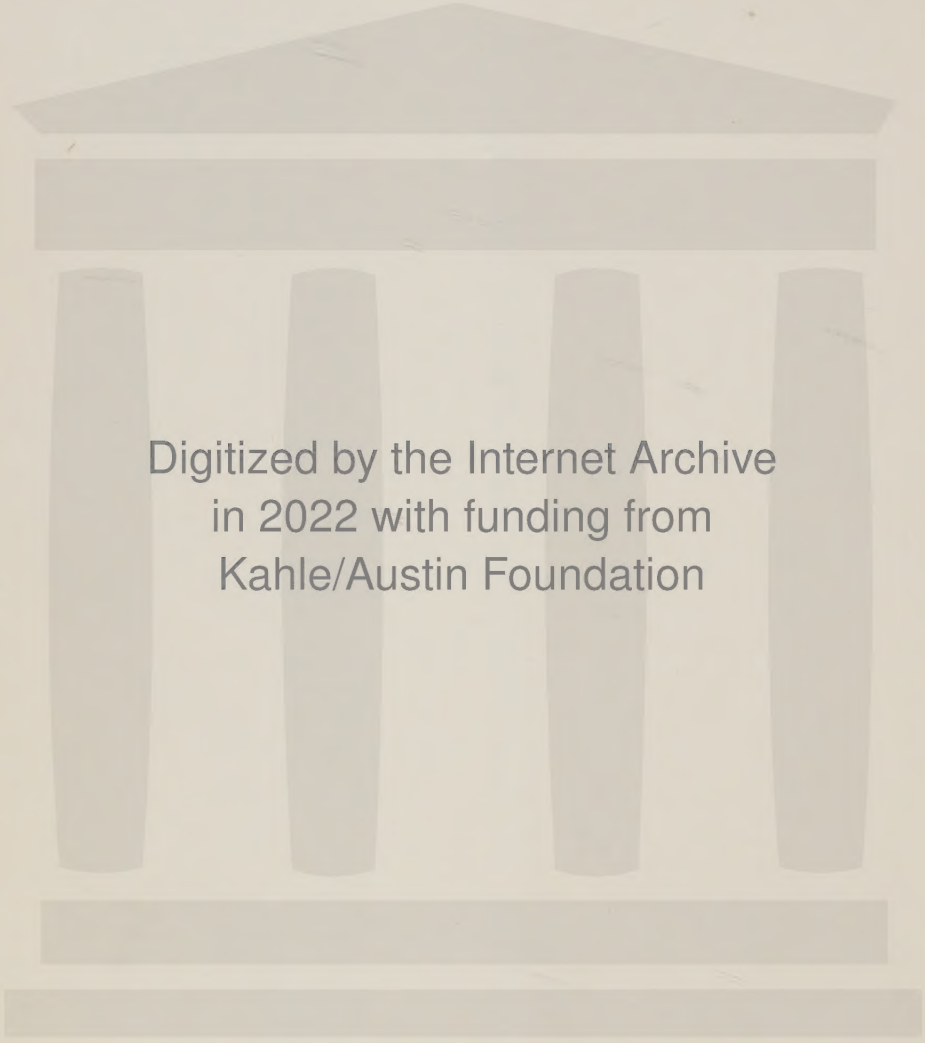
Charles Frodsham's great-grandfather, William Frodsham, was the founder of the London clockmaking Frodsham firm. He opened a shop at Kingsgate Street in 1796, and William's grandson, John, inherited this business.

Charles Frodsham's brother, Henry, became the owner of a business at Liverpool. There were therefore four firms of Frodshams in existence at one and the same time, all competing with one another for business, but nevertheless willing to give one another a helping hand at times.

Of these four firms only one still remains, i.e., Charles Frodsham and Co. Ltd. The book explains how the firm of Nicole Nielsen became more and more involved with the manufacture of watches for Charles Frodsham's firm. Most of the later masterpieces of watchwork were made by them and anyone owning a Frodsham tourbillon, especially one with complications, is indeed to be envied.

A chapter is devoted to the various types of tourbillon and karrusel likely to be found in English watches.

In addition to the story of all these Frodshams and the ramifications of that story this book is designed to be a work of reference which should be invaluable to both scholars and collectors.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THE STORY OF THE
FRODSHAMS

Frontispiece : **Charles Frodsham.**
Photograph by Hennah & Kent of Brighton.

THE FRODSHAMS

THE STORY OF A FAMILY OF Chronometer Makers

by VAUDREY MERCER
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Author of: 'John Arnold & Son'
'Edward John Dent and his Successors'

With an introduction
by Frank Leslie Thirkell

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PREFACE

This volume completes the saga of the Arnolds, Dents and Frodshams. However, since both E. Dent & Co. Ltd. and Charles Frodsham & Co. Ltd. are still in existence, the stories cannot be said to have reached their conclusion.

In all my researches, which now cover a period of some fourteen years, I have come to appreciate, more and more, the work of Commander R. T. Gould; whenever I have had occasion to refer to *The Marine Chronometer*, I have been astounded to realise how much research he must have undertaken. To have made notes from all the Airy papers which have any connection whatsoever with the chronometer, must have been a mammoth task. Gould's work is invaluable as a starting point for further research. And so, once again, the Airy papers have proved to be one of the main sources for the details of this story. What a debt we owe to Airy for the business-like way in which he preserved every letter he received and kept a tissue paper copy of his replies.

As before, I have endeavoured to present the facts in a, more or less, chronological order for each of the four firms which form the basis of this book. A large section of the book is devoted to the appendices which contain a number of family trees and various records concerning the use of numerous watches and chronometers. I hope these will be of interest to both collectors and dealers as well as to the descendants of the Frodshams.

Little Morton,

R. Vaudrey Mercer.
1981.

ACKNOWLEDGEMENTS

This book could not have been written without the help of a number of people and I am most grateful to all of them for their interest and for the information they have provided.

The late Miss Dorothy Frodsham, the grand-daughter of Henry Frodsham, had been most helpful, not only concerning her own side of the family but also by helping me to trace a number of her relatives. Without exception all these relatives have been most co-operative and they have enabled me to build up the various family trees shown in the appendices. I am more than grateful to Colonel Quill for giving me the address of Dorothy Frodsham and for allowing me to use his notes referring to the Frodshams and the Harrisons.

Frank Thirkell, who used to be in charge of the firm of Charles Frodsham & Co. Ltd., when it was at 173 Brompton Road, has given me much advice and information concerning the firm, its directors and employees, and also the details of the various products of the firm. Mr. Thirkell has been kind enough to correct my version of the story of the company, thereby making this section much easier to understand.

W. A. Kermock (at one time the manager of the clock repairing department at Charles Frodsham & Co. Ltd.) has been very kind in lending me a number of photographs which have been used to illustrate this book.

John Mercer, of Devon Instruments Ltd. who now have control of Frodshams, has been most helpful by allowing me to borrow the various manufacturing books and ledgers which have survived since the days when the firm became a Limited Company. I am extremely grateful to him. An extract of the manufacturing books is given in one of the appendices.

The Airy Papers are invaluable to anyone researching the histories of the clockmakers of his time and I am indebted to Philip Laurie and to Miss J. Dudley for allowing me to examine the original manuscripts at Herstmonceux. It is by the courtesy of the Royal Greenwich Observatory that I have been permitted to quote extracts from these documents. Copies of all the Airy Papers concerning chronometry are now at the National Maritime Museum at

Greenwich and Lt. Cdr. H. D. Howse, Dr. J. A. Bennett and Beresford Hutchinson have been of great assistance in allowing me access to these papers and to the Chronometer Ledgers. Extracts from these ledgers concerning the use of nearly 300 chronometers are to be found in one of the appendices.

Eric Street, at one time Editor of *Antiquarian Horology*, is an expert reader of authors' manuscripts and I cannot thank him enough for the painstaking way in which he has helped to tidy up my script by correcting errors and by making numerous suggestions for improving and clarifying various passages.

Charles Allix, a fount of knowledge, has given me much help especially in connection with the statements regarding watch glass sizes. I am extremely grateful for his permission to publish the "Comparative Table", a very useful document. Many years ago he lent me Mr. Moon's notes on the Frodsham story, these have proved to be most helpful.

Tony Mercer's book is a splendid source of information, especially regarding the manufacture of chronometers.

Mrs. Beryl Harris (whose husband used to own Parkinson & Frodsham), and K. G. Brown, have been kind enough to lend me the few surviving work books of the firm of Parkinson & Frodsham. They have been more than generous in deciding to present these books to The Clockmakers' Company library at Guildhall.

D. J. Blackwell, an authority on the watches of the Charles Frodsham firm, has supplied me with a vast amount of information concerning their design and numbering, etc. I am particularly grateful to him for his kindness in doing this, since, if he had been living in this country, he could well have written this story himself.

The Museums and Libraries have been most helpful and, in particular, I should like to thank the following :—

The British Library.
The British Museum (Beresford Hutchinson and R. Good).
The British Horological Institute.
The Central Library, Islington (E. A. Willats).
Cheshire Record Office.
The Clockmaker's Company.

Dorset County Record Office (Miss M. E. Holmes).
Guildhall Library.
Holborn Reference Library.
Liverpool Record Office (Miss N. Evetts and Miss J. Smith).
The National Maritime Museum Library, Greenwich.
National Physical Laboratory, Teddington (D. S. Sutcliffe and B. Swabey).
National Trust (re Arlington Court).
The Patent Office.
The Public Record Office.
The Rose Lipman Library, Hackney (S. C. Tongue).
Somerset House and St. Catherine's House.
Southampton Record Office (Miss S. D. Thomson).
Surrey County Council, Ewell (Miss J. Overy).
The Westminster Library.

The individuals and firms who have been most helpful in one way or another include :—

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A. F. Frodsham.
Mr. & Mrs. A. M. Frodsham.
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J. H. S. Frodsham.
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Dr. P. Ward-Platt.
S. W. Watkinson.
J. Weinberg.
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J. Woodhouse
G. Worswick.
Mrs. B. Woycicki.
R. F. Zbinden.

I wish to thank all those people who have helped me in this enterprise and I do apologise to anyone whose name I have failed to mention. Many of you have sent photographs of great interest and I very much regret being unable to use all of them as illustrations for the book, but I hope the ones I have selected will prove adequate.

Last, but by no means least, I should like to thank E. P. Wilson of the Antiquarian Horological Society for all the trouble involved in forwarding the many letters I have received in reply to my request for help.

INTRODUCTION

Early in 1951 Philip Clowes dropped a file, relating to Frodsham history, on my desk and said, " This will be your job in future ". His untimely death in June of that year halted the progress of the plans we then had for the Company, including further research into, and publication of, the Frodsham story.

On many occasions since then I have looked at that file, sometimes adding a few notes of my own, and considered whether I could possibly undertake the work. The magnitude of the task invariably deterred me from proceeding, but I have always hoped that, one day, a worthy account of the Frodsham contribution to horology would be published.

The present volume fulfils that hope. No one could be better qualified for the task than Dr. Vaudrey Mercer. He has already written enthralling accounts of the two great horological families of Arnold and Dent and this book will complete a trilogy which will be a standard source of information for all future students of 18th and 19th century watch and clock making.

F. L. Thirkell.

CONTENTS

Chapter		Page
	Preface	v
	Acknowledgements	vii
	Introduction	xi
I	**The Early Frodshams**	1
	Ancestry	3
	Simplified Family Tree	8
II	**The Clockmaking Frodshams**	9
	William Frodsham (The Elder)	10
	Earnshaw-Frodsham Friendship	12
	Harrison-Frodsham Friendship	13
	William Frodsham (The Elder) His Will	14
	William Frodsham (The Younger)	15
III	**The Frodshams of Kingsgate St. and Gracechurch St.**	17
	Family Tree	18
	John Frodsham	17
	Frodsham & Baker, 1808 - 1809	17
	John Frodsham & Son	19
	Frodsham & Baker, 1854 - 1863	19
	George E. Frodsham	20
IV	**Parkinson & Frodsham Part 1**	22
	Apprentices	23
	North West Passage	24
	Arctic Expeditions	27
	Sabine's Pendulum Experiments	28
	North West Passage	31
	Change in Rates in Chronometers	34
	Vibration of Pendulums	37
	Mercurial Pendulum	42
	Quick Trains	42
	Balances	43
	William James Frodsham's Will	47
V	**The Family of William James Frodsham**	52
	Henry Frodsham	52
	William Edward Frodsham	52
	Charles Frodsham	53
	John Frodsham	53
	George Frodsham	54
	William Frodsham	54

		Page
VI	**The Liverpool Frodshams**	56
	Parkinson & Frodsham	56
	Henry Frodsham	57
	Frodsham & Keen	59
	Henry Herbert Frodsham	61
VII	**Parkinson & Frodsham Part 2**	64
	George and William Frodsham	64
	George William Frodsham	65
	Frodsham Black Book	65
	Vulliamy	66
	Electricity and Magnetism	66
	Exhibitions	67
	Outil aux Douzième	68
	Livingstone Search Expedition	69
	Mrs. Belville	69
	William Charles Shrubsall Harris	72
	Geoffrey Charles Harris	74
VIII	**Charles Frodsham**	76
	Greenwich Trials	76
	Arnold Charles Frodsham	78
	Arnold Frodsham & Co., Liverpool	79
	Quick Trains	79
	Frodsham Arnold Balance	80
	Middle Temperature Error	84
	Theoretical Cure	84
	Airy's Remontoir	85
	Balance Spring	86
	Uncompensated Balances	88
	Rusting of Blued Steel	92
	Telford Medal	93
	Greenwich Time	96
	Aneroid Barometer	99
	AD Fmsz	99
	Great Exhibition of 1851	100
	New Calibre	100
	Reversed Fusee	102
	Split Centre Second's-Hand Watch	104
	Double Rotary Escapement	104
	James Ferguson Cole	106
	The Spanish Pamphlet	107
	Vulliamy's Business Acquired	110
	The English Chronometer	111

		Page
	Table of Trains	113
	William Johnson's Business Acquired	114
	International Exhibition, 1862	115
	Elements of Watch and Clock Making	118
	Lancashire Gauge	118
	Watch Glass Sizes	123
	Tables	127
	Mercurial Compensation Pendulums	128
	Paris Exhibition, 1867	132
	Galvanic Apparatus	133
	Large Impulse Roller	134
	Will of Charles Frodsham	143
	A Fortune in Chancery	146
IX	**The Family of Charles Frodsham**	150
	John Mill Frodsham	150
	Charles Mill Frodsham	150
	Harrison Mill Frodsham	154
	Elizabeth Frodsham's Will	155
X	**Charles Frodsham & Co.**	158
	Gravity Escapement	158
	Galvanic Chronometer	159
	Exhibitions and Awards	159
	Hutton Chronometer No. 138	160
	Harrison Mill Frodsham's Patent	161
	Resumé of Remontoires	163
	Trochilic Escapement	166
	Charles Frodsham & Co. Ltd.	167
	A. E. Rutherford, Manager	169
	Speedometer & Motor Accessories Department	169
	W. Rock	169
	H. J. Furneaux's Patent Speedometer	170
	Donald de Carle	170
	Jane Grace North	171
	Robert Benson North	171
	Magneta Time Systems	172
	J. M. Ellison	174
	Philip Arthur Clowes	175
	Gladys Yule	176
	Clock Manufacture	178
	Frank Leslie Thirkell	183
	Philip Thornton	184
	Micron Instruments	186
	W. A. Kermock	187

		Page
	The Trade Sign	188
	Ship's Bell Clock	188
	Camera Timers	190
	Arthur Cover	191
	W. H. French	193
	Devon Instruments Ltd.	195
XI	**Nicole Nielsen & Co.**	198
	Watford Speedometers	203
	North & Sons Ltd.	203
	Henry Capt	204
XII	**Varieties of Charles Frodsham Watches**	206
	Floating or Hanging Barrel	206
	Half-Chronometers	206
	Time of Flight Instrument	207
	Tourbillons and Karrusels	209
	Tourbillons:	
	Breguet	211
	Andrew Taylor	212
	Robert Benson North	212
	Joseph Burtin	213
	Karrusels:	
	Bonniksen	213
	W. & E. A. Holland	214
	William Henry Douglas	215
	List of Tourbillons and Karrusels	215

Appendix		Page
I	**The Frodshams of Elton Family Tree**	221
II	**Alice Frodsham Family Tree**	222
III	**William James Frodsham Family Tree**	224
IV	**George Horsfall Frodsham's Family Tree**	237
V	**Edward Frodsham's Family Tree** An American Branch	238
VI	**Mary Maria Frodsham's Family Tree**	240
VII	**Business Premises and Titles**	242
VIII	**Chronology as Regards Numbering**	244
	Dating Watches by their Hallmarks	245
IX	**Parkinson & Frodsham Manufacturing**	248

Appendix		Page
X	Charles Frodsham Manufacturing	255
XI	Movements made by Victor Kullberg	263
XII	Chronometer Clocks made by Thomas Mercer	265
XIII	Greenwich Trials, 1840 - 1914	266
XIV	Kew Certificates	272
XV	Chronometer Records, Greenwich	283
XVI	The Lancashire Gauge	319
XVII	Charles Frodsham Tables	322
XVIII	Charles Frodsham's Register or Split Centre Second's-Hand Watch	325
XIX	A Comparative Table of Watch Glass Sizes	327
Bibliography		334
List of Illustrations		340
Illustrations		344
Special Index Numbering		437
Special Index Ships		444
General Index		451

CHAPTER I

THE EARLY FRODSHAMS

In tracing the origins of a family such as the Frodshams it is most helpful if one can find an old family bible with notes in it which will be of use in the making of a family tree. In this case I was extremely fortunate in being allowed to examine two such bibles. It is, however, exceptional to discover that in bygone days some members of the family have also been sufficiently interested to investigate their ancestry and to make notes of their findings. Colonel Quill, who has been most helpful, told me of the possible existence of a " Black Book " compiled by one of the Frodshams. By great good fortune I have been able to trace three copies of this book made by various members of the family, each copy is almost identical, the only difference being the addition of extra facts.

The first to become interested was the wife of Henry Frodsham; in 1855, having heard that there was a small fortune held in Chancery awaiting a rightful claimant, she decided, at the suggestion of Charles Frodsham, to examine the relationship of former Frodshams in the hope of finding a link in order to establish a claim to the money. She visited Chester, made notes of a number of Wills deposited there and then went to some of the churches in the vicinity to examine the registers of baptism, etc. In due course, her son, Henry Herbert, gathered all these notes together to make a small volume which became known as, " Herbert Frodsham's Book ". This is the Henry Herbert Frodsham mentioned on page 61. His father was also " Henry ", and so, to avoid confusion, the son was known as Herbert Frodsham.

Some years later, Mrs. Mary Maria Frodsham (the wife of George William Frodsham) became extremely interested in the family history. She made careful notes from several books, one, entitled *The Ancient Town of Frodsham in Cheshire*, written by William Beamont and published in 1881, another being George Ormerod's *History of Chester*, published in 1818, which contains details of the

Frodshams who lived at Elton (near the town of Frodsham). These notes, together with a number of other records, were added to the Herbert Frodsham manuscript, and the whole collection was painstakingly written out in a book having a " black " cover. To give some idea of the size of this " black book ", one of the copies consists of 105 pages, another, 93 pages and the third, which is typewritten, has 73 pages. The original was completed in 1902, but Mary Maria continued to add notes from time to time until her death in 1917.

The " Black Book " has therefore been the main source of the information concerning the early history of the Frodshams, which now follows.

The family name, **" Frodsham "**, must obviously stem from the town of that name. The town of Frodsham lies 10 miles north-east of Chester at the confluence of the rivers Weaver and Mersey, and about 10 miles west of Northwich. The name is derived from, " Frotesham ", as it is spelt in the Doomsday Book. It would therefore seem likely that in early Saxon times there lived a family known as the " Frotes ", or " Froti ", whose home or " ham " became known as Frotesham, changing later to Frodesham, and finally to Frodsham. **Plate 1**, page 344.

Frodsham Church

This was built in Saxon times in about the year 913, probably by Elfreda, the daughter of King Alfred, and the wife of Earl Edwin of Mercia. The church is situated at Overton, $1\frac{1}{2}$ miles south-east of Frodsham.

The Norman Conquest

With the arrival of William I, Earl Edwin (who had been the Lord over Frotesham) was ousted, and Hugh Lupus (nephew of the Conqueror) was made Earl of Chester. In due course Earl Hugh Lupus' daughter is said to have married John de Frodesham.

Frodsham Castle

This castle was built by Earl Lupus in about the year 1070. Unfortunately it was burnt down in 1654; its owner was then, John, Viscount Savage, Earl Rivers, who died the very day before the castle was burnt.

Frodsham Bridge

A bridge was built over the river Weaver, one mile north-east of Frodsham; it was probably constructed at about the time that the castle was built. In due course a small hamlet developed in the neighbourhood of the bridge.

It has been suggested that another branch of the Frodshams sprang up here, giving rise to " The Castle Frodshams ", and " The Bridge Frodshams ". It has also been said that, at one time, there had been a feud between these two families.

So much for the origin of the town and of its name, let us now consider the people who lived in Frodesham, or, came from Frodesham. The earliest mention of the name is, as already stated, the marriage of John de Frodesham to the daughter of Earl Hugh Lupus; this must have raised his standing and that of the future members of his family considerably. The early records are of some interest although the relationship of one member of the family to another is rarely mentioned. The following is a summary of these records :—

1189	(Richard I)	**Robert de Frodesham** is mentioned in the Arley Charters (Arley is situated about 11 miles east of Frodsham).
1189 - 1199	(Richard I)	**Peter de Frodesham** was living at Frodesham Castle.
1209 - 1211	(John)	**Ranulphus de Frodesham** was the " Clericus de Frodesham ", i.e., Clergyman or Vicar of Frodesham.
1228 - 1240	(Henry III)	**Peter de Frodesham** was Bailiff. (Every Manor had its " Court-Baron " or " Court-Leet ", or both, and to every large Lordship, like Frodesham, both these Courts belonged. The Court of the Hundred of Roelan or Edisbury would also have been held at Frodesham, and its chief officer was the Bailiff.)
1249 - 1260	(Henry III)	**Henry de Frodesham** and **Robert de Frodesham** were Bailiffs.
1276 - 1300	(Edward I)	**Robertus de Frodesham** was the Vicar.

1347 (Edward III) **Robert de Frodesham,** son of another of that name, was the subject of an " Inquisition Post Mortem ". Could this have been a Post Mortem investigation regarding the possessions of the old Vicar ?

1352 - 1353 (Edward III) **Robert Fitz Robert de Frodesham** was one of the Bailiffs at Frodesham under Edward, the Black Prince, who was at that time the Earl of Chester. (Fitz means " the son of " and was sometimes applied to illegitimate sons. Could Robert have been the son of the Vicar whose wife could have died before he took holy orders ?)

1357 (Edward III) Frodesham Manor was owned by the Earl of Chester.

John Fitz Walter de Frodesham was Bailiff of the Manor from 1320 to 1326, and the Manor was farmed by **Richard de Frodesham** and Peter de Thornton. By 1357, the Manor seems to have been granted to the **Frodesham** family who were said to live in the Castle.

Thomas Fitz John de Frodesham would appear to have incurred a forfeiture by having slain a Prince's favourite in an affray. However, by reason of his having done good service at the Battle of Poitiers, and in Gascony, he was pardoned by the Black Prince in 1357, " for all offences he had committed in the County of Chester, except concerning the Prince's Ministers ".

In the same year **Thomas de Frodesham** was granted the lucrative office of Hayward (one who herded the common cattle of a town) of Frodesham Marsh.

1362 (Edward III) **William de Frodesham** gained three messuages (dwellings) and three bovates of land in Elton when he married Felicia, the grand-daughter and co-heiress of Thomas de Elton (Elton lies 4½ miles W.S.W. from Frodsham).

This then was the way in which the branch of the family, known as **"The Frodshams of Elton"**, began.

(A "bovate" = as much land as one ox could plough in one year. It varies from 10 to 18 acres.)

1386 (Richard II) **John de Frodesham** and Richard Torfote farmed the Manor, under the King, and were the King's Bailiffs. In the same year, however, John de Frodesham was issued letters by the King, ordering him to deliver up the Manor to Radagunda Becket, Lady Mortimer.

1394 (Richard II) **William de Frodesham of Elton** Esquire was made Chamberlain of North Wales. Richard II then ordered his keeper of Shotwick Park to deliver to William de Frodesham, twenty oaks for the repair of his Castles and Mills in North Wales.

1397 (Richard II) **William de Frodesham** died, and, after his death, it was said that he held lands and burgages (leases) in Frodesham, under this Radagunda Becket, to whom the King had granted the Manor for life. In 1398, the Escheator (confiscator) was

		commanded to seize into the King's hands, all the lands which William had acquired and which he held of the King. The King then granted a lease of two-thirds of these lands to John Donne, of Utkinton, and one-third to Richard Chetwynd.
1403	(Henry IV)	The King granted to **William de Frodesham** (son of the above William de Frodesham), all the lands which had been granted by mistake to John Donne and Richard Chetwynd. Incidentally, **William de Frodesham,** Junior, was the Ward of John Donne and married his daughter.
1426	(Henry VI)	**John de Frodsham** is mentioned, and in 1441 his age is given as 47.
Later		**William Frodsham of Elton,** married Margery, daughter of William Bordsley of Manchester.
		Thomas Frodsham of Elton, married Mary, daughter of Ingram Longworth, Gent. Co. Palatine. Lancashire.
1536?	(Henry VIII)	**Edward Frodsham of Elton,** married Margaret, daughter of John Bunbury of Stanney, Esquire, by Agnes, daughter of William Norrey of Speke.

The branch of the family known as the **Frodshams of Elton,** who had previously resided at Frodsham Castle, became extinct in 1766 by the death of **Peter Frodsham of Elton** who died without leaving any male heir to carry on the name.

For their family tree, see **Appendix I**, page 221.

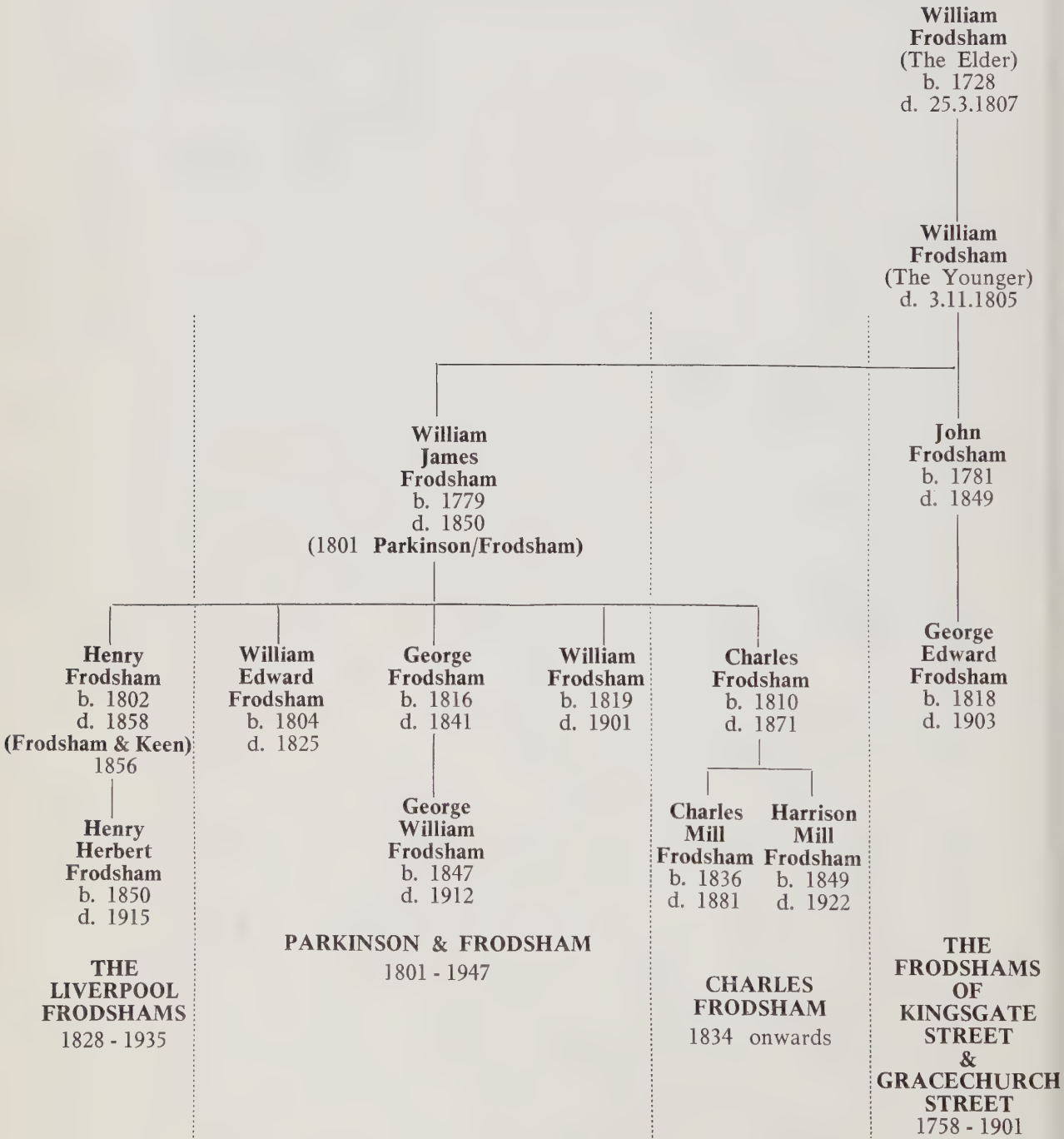
Frodsham Castle and Manor were purchased in the year 1616 from the King (James I), by Sir Thomas Savage of Rock Savage and Halton Castles. **Plate 1**, page 344.

There is in existence an interesting "**Frodsham Scroll**" which goes back to the Castle Frodshams, the earliest being Tobias whose son was Hagatheil. Then comes Thomas Frodsham whose son, Richard married Isabill of Elton, their son being, Bimamye, the father of the above William Frodsham of Elton. The next in line is Thomas the father of Edward. From then onwards the scroll agrees with the Elton family tree as shown in **Appendix I.**

Prior to 1536 no proper records were kept by the parish churches, and so Cromwell, the Minister of Henry VIII, suggested that church registers should be kept. His ordinance, that such a register should be kept in every parish, was first issued in 1536.

From these early Frodshams the family tree gradually spread its branches, as its members migrated to the neighbouring towns and hamlets. Many church registers contain the name of Frodsham, but so far it has not been possible to trace the exact origin of the London clockmaking Frodshams, who may well have come from Frodsham, Elton, Northwich, Liverpool, Prescot, Huyton, etc., etc. Several of the Frodsham chronometer makers had premises in Liverpool at one time or another, for example "Parkinson & Frodsham", "Henry Frodsham" and the branch of "Charles Frodsham" known as "Arnold, Frodsham & Co." of Royal Exchange, Liverpool, so that there seems to have been a pull in that direction.

Simplified version
of the
FRODSHAM FAMILY TREE


William Frodsham (The Elder) b. 1728 d. 25.3.1807
William Frodsham (The Younger) d. 3.11.1805
William James Frodsham b. 1779 d. 1850 (1801 Parkinson/Frodsham)
John Frodsham b. 1781 d. 1849
Henry Frodsham b. 1802 d. 1858 (Frodsham & Keen) 1856
William Edward Frodsham b. 1804 d. 1825
George Frodsham b. 1816 d. 1841
William Frodsham b. 1819 d. 1901
Charles Frodsham b. 1810 d. 1871
George Edward Frodsham b. 1818 d. 1903
Henry Herbert Frodsham b. 1850 d. 1915
George William Frodsham b. 1847 d. 1912
Charles Mill Frodsham b. 1836 d. 1881
Harrison Mill Frodsham b. 1849 d. 1922
THE LIVERPOOL FRODSHAMS 1828 - 1935
PARKINSON & FRODSHAM 1801 - 1947
CHARLES FRODSHAM 1834 onwards
THE FRODSHAMS OF KINGSGATE STREET & GRACECHURCH STREET 1758 - 1901

CHAPTER II

THE CLOCKMAKING FRODSHAMS

At one time there were four Frodsham firms of clockmakers, all related to one another, all first-class chronometer makers, and all working in friendly competition with one another, each being willing to give a helping hand to any of the others if and when needed. Three had their business premises in London, whilst the fourth worked in Liverpool. The simplified family tree shows how these firms were all descended from a common ancestor.

The story of the Frodshams is in some ways reminiscent of the Dent story. Edward John Dent, the founder of the Dent firm, bequeathed his business to his two watchmaking step-sons, each one having his own business premises, so that they no longer worked for the common good but were in competition, one with the other.

In the case of the Frodshams, the founder of the firm was **William Frodsham (The Elder),** and he had two watchmaking grandsons. During his lifetime he provided one of his grandsons, **William James Frodsham,** with sufficient property to enable him to set himself up in business in partnership with William Parkinson under the title, " **Parkinson & Frodsham** ". The other watchmaking grandson, **John Frodsham,** was bequeathed his grandfather's own business (John's father, William [The Younger], having already died) and this side of the business became " **John Frodsham** ". Here again these two firms were competing with one another.

As we shall see, William James Frodsham had several sons; four of them joined " Parkinson & Frodsham ", but the eldest, **Henry Frodsham,** went to Liverpool and eventually became the owner of that business, whilst a sixth son, **Charles Frodsham,** opened his own premises in London, in competition with his father's firm of " Parkinson & Frodsham ".

This explains how there came to be four separate Frodsham chronometer-making firms in existence at the same time.

There is some uncertainty regarding the ancestry of the first William. The following is, however, as far as it is known at present, the story of the four firms which developed from the original firm of William Frodsham.

William Frodsham (The Elder), 1728 - 1807

His father, whose christian name is unknown, is said to have been a journeyman watchmaker working at times for Justin Vulliamy.

Let us consider the facts, and try to decide who this unknown Frodsham could have been. There are two possible William Frodshams who were apprenticed at about this time; the Clockmakers' Company records are as follows :—

1. " **Henry Frodsham,** a victualler of Northwich, Cheshire, whose son, William was apprenticed to William Addis of Birchin Lane, London on 14 April 1760. £10. 7 years. Made an Honorary Freeman 2 April, 1781."

   But William (The Elder) was, we believe, born in 1728, and would have had to be apprenticed at the age of 32 in 1760. To try to prove that Henry could not have been his father the records of baptisms at Northwich were examined and show that this William was baptised on January 30th, 1745.

2. " **Jonathan Frodsham,** a coachman of St. Paul, Covent Garden, whose son, William was apprenticed to William Addis on 14 January, 1750. £10. 7 years."

   But William (The Elder) would have been 22 in 1750. Unfortunately no record of the baptism of a William Frodsham was to be found in the records of St. Paul, Covent Garden, which were searched from 1726 to 1739. It seems to be unlikely that Jonathan could have been William (The Elder's) father, since apprenticeships were, in those days, usually only allowed to be accepted during the 14th year of the age of the apprentice. One final point, William (The Elder's) father is supposed to have been a watchmaker who worked as a journeyman for Justin Vulliamy; now G. H. Baillie gives Justin's dates as 1730 -

ca. 1790, it therefore seems to me quite possible that William Frodsham (The Elder) was himself the journeyman in question, since Justin, who had been the partner of Benjamin Gray, did not acquire the business for himself until Benjamin's death in 1764. So, it is just possible that Jonathan was William (The Elder's) father, if for some unknown reason William was apprenticed at the age of 22. Otherwise we have to look for :—

3. **A Frodsham,** possibly also " William ".

Supposing this Frodsham was born in about 1700, he could have had two sons, one, Henry, born say in 1722, whose son, William, was born perhaps in 1745, being apprenticed at the age of 15, in 1760, to William Addis; the other son, William, born in 1728, who became known as " The Elder ", since he had a son of the same name. This son was therefore referred to as " The Younger ".

William (The Elder)

Born in 1728. Married to Mary (? Barber) before 1758. In April, 1759, when his third child was born, his address was Kingsgate Street. As already pointed out he may have worked as a journeyman for Justin Vulliamy, but he certainly worked as a watch-jeweller for a time, and then, " having been taught a better method by his friend, Thomas Earnshaw ", he is said to have opened his own shop in 1796, at **12 Kingsgate Street, Red Lion Square, Bloomsbury;** he was then aged 68.

On April 2nd, 1781, he had been made an Honorary Freeman of the Clockmakers Company (see *John Arnold & Son*, page 138). Several examples of his work are known :—

No. 568, a pocket watch having a hallmark for 1766, signed William Frodsham, Red Lyon Square, London. Verge escapement.

No. 850, a pocket watch in a Pinchbeck case, signed Wm Frodsham, London. Verge.

No. 951, a verge movement, signed William Frodsham, London.

No. 1122, gilt metal pair case. Signed William Frodsham, Red Lyon Square, London. Verge escapement.

No. 2579, gilt metal and tortoiseshell pair case. Signed William Frodsham. Verge escapement.

From the above it would appear that he was making watches thirty years before he opened his shop. None of these watches is signed " Kingsgate Street ", and we must bear in mind that, as shown in the records of apprentices, there were at least two and possibly three people trained to be watchmakers, each having the name " William Frodsham " and possibly living in London at this time. However, it seems unlikely that there was one William living in Kingsgate Street with another William living, just behind Kingsgate Street, in Red Lion Square (see map, **Plate 2**, page 345). Kingsgate Street no longer exists. This was a popular area for watchmakers; John Harrison lived in Red Lion Square and was on very friendly terms with William Frodsham, and, Thomas Earnshaw, who was a great friend of William and much admired by him, lived just around the corner from Kingsgate Street at 119 High Holborn.

The Earnshaw - Frodsham Friendship

As already mentioned, William had been taught a better method of jewelling watches by Earnshaw, and in 1804, when the Board of Longitude asked him to give evidence regarding Earnshaw's claim for a reward, William was in a quandary. He was, in spite of being 76 years of age, still being employed as a watch-jeweller and one of the makers he worked for was Miles Brockbank, a supporter of John Roger Arnold. Nevertheless, in spite of this, William eventually agreed to give evidence in support of Earnshaw's claim for a reward. On March 1st, 1804, William was examined by the Board of Longitude, and, on being asked when it was that he had seen Earnshaw making the improvements in the detached escapement, he replied, " The latter end of 1780, and the beginning of 1781. I was then particularly intimate with Mr. Earnshaw, and he hardly did any thing which I did not know. He was then a private workman." The Board's next question was : " Previous to Mr. Earnshaw's improving the detached escapement, did you ever hear of Mr. Arnold, or of any other person, being employed in improving that part of the watch ? ". To which William Frodsham replied :

"Not till after Mr. Earnshaw's was out. He shewed it to Mr. Vulliamy and my father, and Mr. Dwerryhouse."

This suggests that William Frodsham's father was almost certainly a watchmaker.

One other point of interest; in two of Earnshaw's petitions dated December 5th and 6th, 1804, he gave the names of five watchmakers who would be willing to support his claim for a reward, they were: Joseph Watkins, George Jamieson, Wm. Jas. Frodsham, Robert Best and Charles Cope. As we shall see, this Wm. Jas. Frodsham could well have been either the son or the grandson of the Frodsham who gave evidence before the Board of Longitude. (B.O.L. Vol. XX, pages 218 & 223).

The Harrison - Frodsham Friendship

There are several reasons for believing that the Harrisons were on intimate terms with the Frodshams, for instance :—

William Frodsham (The Elder), in conjunction with Walter Williams (an attorney), signed a 203-page manuscript copy of the Journal kept by John Harrison and his son, William, which described their dealings with the Board of Longitude during the period 1761 to 1766.

This same William Frodsham witnessed a codicil to John Harrison's Will in July, 1770.

William Frodsham (The Younger) is said to have married John Harrison's grand-daughter, Alice.

William Harrison signed his name, on the 18th June, 1785, to the marriage settlement of "Edward Frodsham, a Watchmaker of St. George the Martyr, Middlesex", to his future wife Sarah Lane of Norton Kirby, Kent. Who was this Edward Frodsham? Could he have been a cousin of William (The Younger)? Unfortunately this is still a mystery, but it seems likely that they were related to one another in some way.

One last point; when William Frodsham (The Elder) made his Will, on the 2nd April, 1806, he appointed William Harrison as the sole executor.

William Frodsham (The Elder's) Family

William and his wife, Mary, had five children.

William, date of baptism unknown. Died 3.11.1805.
Mary, baptised 13.11.1757. Died 1773?
John, baptised 1.4.1759. Died before April, 1806.
James, baptised 15.2.1761. Died in September, 1761.
George, baptised 2.8.1762? Died in 1819.

Titles of the Firm

1758 ?	**" William Frodsham "**	William (The Elder) on his own.
1779 ?	**" William Frodsham & Son "**	when William (The Younger) became a partner.
1806	**" William Frodsham & Son "**	when John, son of William (The Younger), became a partner.
1807	**" John Frodsham "**	following the death of William (The Elder).

To return to William (The Elder), in 1801, when his son William was alive and therefore expected to inherit the business, William (The Elder) gave his eldest grandson, William James Frodsham, sufficient money to enable him to become the partner of William Parkinson and to commence a business on their own at Change Alley.

Unfortunately his son, William (The Younger), died in 1805, and so, on 2nd April, 1806, William (The Elder) made a Will, as already mentioned. One year later, in March, 1807, William (The Elder) died, his Will being proved on the 2nd June.

William Frodsham (The Elder's) Will

The following is an extract giving the important points in the Will :—

Public Record Office. Probate 11 - 1462
f.492

This is the last Will and Testament of me William Frodsham of Kingsgate Street in the Parish of St. George the Martyr in the County of Mddx clock and watch maker First I give to my grand-

son William Frodsham £10 he having already had from me his full share of my property and I direct that if at my death I shall hold or be possessed of any bond or security of his for money the same be cancelled I give to my grandson John Frodsham all my household furniture plate silver and household effects and all my stock of clocks and watches and other stock in trade and tools in my business and all my clothes and effects in my house at my decease (except cash notes bonds and other securities for money and my books of account in trade) to and for his absolute use and I give my son George Frodsham one full moiety or half part of whatever stocks or funds in the Bank of England and in the Imperial Loan I may be possessed of or entitled to at my death the other half part unto my daughter-in-law Alice Frodsham widow of my deceased son William Frodsham money . . . if she remarries the money passes to her three youngest children Mary, Alice and Edward.

Witnesses. Thos Price, Kingsgate St.
George Mitchell, Orange St.

William Frodsham known as "The Younger"

The deceased son mentioned in the above Will. He was born in about 1755 and married to Alice before 1779. It has been said that this Alice was the grand-daughter of John Harrison, but Colonel Quill has not been able to find any evidence to this effect. One of John Harrison's children was "Elizabeth" who married John Barton. Although the Bartons lived at one time in Red Lion Street, moving later to Enfield, no record of the marriage of William Frodsham has been found at St. George the Martyr, Bloomsbury or at Enfield.

The records seem to suggest that at about the time of this marriage, William became a partner with his father, and the firm became "William Frodsham & Son".

William (The Younger) and Alice had five children :—

William James, born on the 25th July, 1779. One of the founders of the firm of Parkinson & Frodsham.

John, born in 1781. Succeeded to his grandfather's firm.

Mary and **Alice.** (See Appendix II for Alice's family tree.)

Edward, born in 1797. Drowned at sea.

William Frodsham (The Younger) predeceased his father and died on the 3rd November, 1805. No Will has been found.

The Two Williams ?

It has always been assumed that William Frodsham (The Elder) was the one to have been taught a better method of jewelling by Earnshaw, but could it have been William (The Younger) ? Unfortunately it has not been possible to answer this question satisfactorily. Let us consider the facts.

Earnshaw had been born in 1749 when William (The Elder) was 21, whereas William (The Younger) was born in about 1755, being therefore 6 years younger than Earnshaw, and so it is possible that the younger William could have been the one to have been on intimate terms with Earnshaw, and it seems more likely that Earnshaw would have " taught " a younger man, whereas he would have been perhaps more likely to have " shown " an older man the new method of jewelling. It could likewise have been William (The Younger) who opened the shop in 1796, when he was 41, whilst his father would have been 68.

There is only one point against this theory, which is that when William (The Elder) made his Will in 1806 he would appear to have been the owner of the business although he was 78 years of age at the time.

We now come to the first parting of the ways. William James Frodsham had already joined William Parkinson in 1801 and the firm of **Parkinson & Frodsham** had been founded.

William Frodsham's firm at Kingsgate Street is now in the name of **John Frodsham.** Let us first consider the story of the continuation of the original firm at Kingsgate Street.

CHAPTER III

THE FRODSHAMS OF KINGSGATE STREET AND GRACECHURCH STREET

As already pointed out the firm is believed to have been founded in 1758 by William Frodsham and then at his death it was bequeathed to his grandson :—

John Frodsham, 12 Kingsgate Street

He was born in 1781 and on the 8th January, 1798, when he was 16, he was apprenticed to Richard Willcocks of Clerkenwell. One penny. He probably joined the firm of William Frodsham & Son in 1805 when he had completed his apprenticeship, becoming a partner soon afterwards following the death of his father. Then in 1807 he became the owner of the business following his grandfather's death, and the firm became known as " **John Frodsham** ". When we remember that he was only 26 and had had very little experience in running a business we can understand why he accepted a watchmaker, by the name of Baker, as a partner a year later, i.e., in 1808, and the firm became :—

Frodsham & Baker, 1808 - 1809

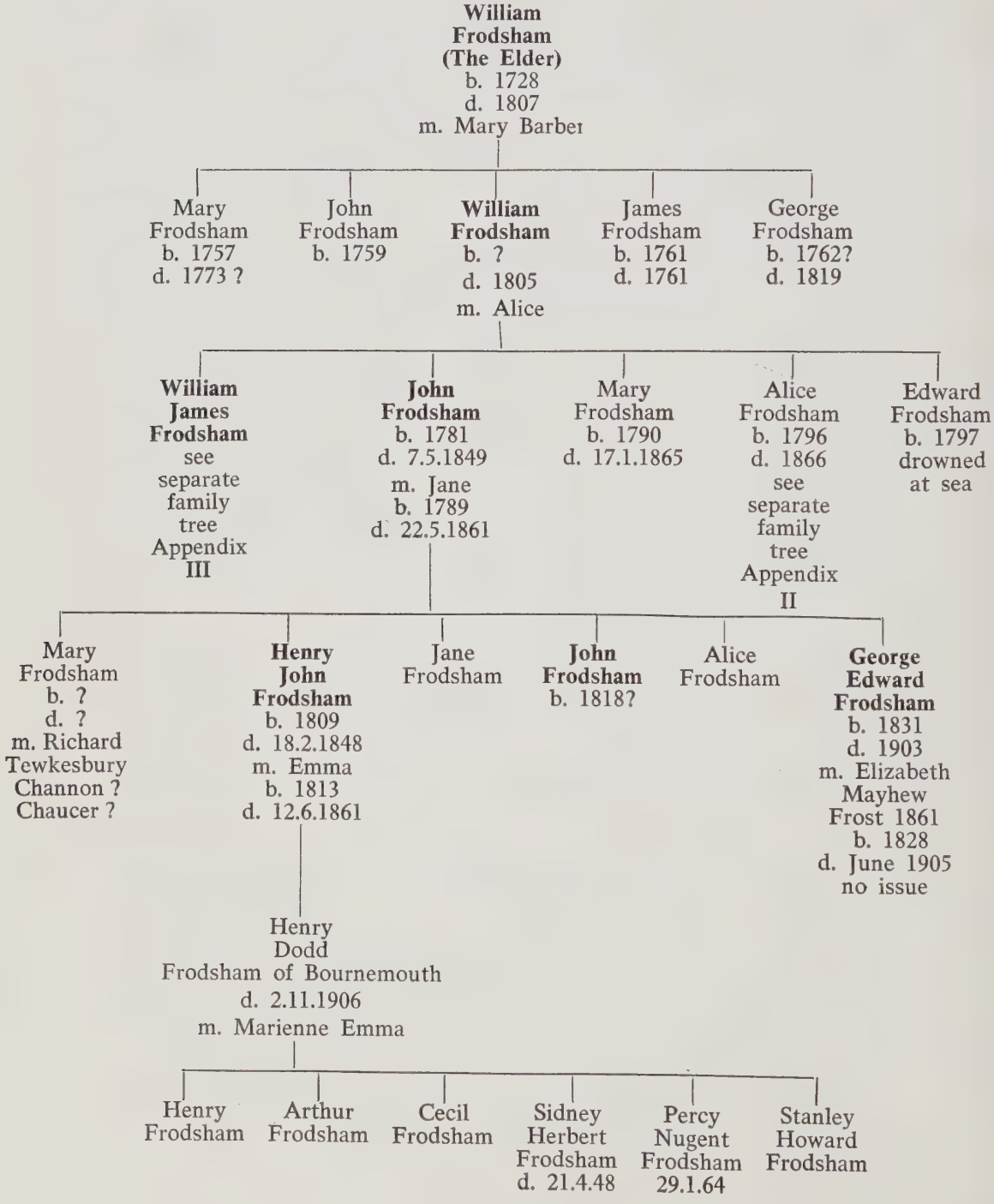
The Post Office Directory gives this as the title of the firm in 1809, but by 1810 the name " Baker " had been dropped and the firm was again " John Frodsham ".

There is in existence the remains of a watch movement bearing the name, Frodsham & Baker, London. No. 1236. It is a full plate movement but has no cock or balance. It probably started as a verge but now has a 30-tooth escape wheel and normal lever escapement.

John Frodsham was granted the Freedom of the Clockmakers' Company on 4th November, 1822. He was still using 12 Kingsgate Street as his place of business until 1824, although in about 1820 he appears to have been living at Enfield Town, Middlesex.

It is difficult to explain why the Post Office Street Directory gives the occupant of 12 Kingsgate Street in 1816 as " Henry Hole, watch and clock maker ".

THE FAMILY TREE OF THE FRODSHAMS OF KINGSGATE STREET AND GRACECHURCH STREET


William Frodsham (The Elder) b. 1728 d. 1807 m. Mary Barber
Mary Frodsham b. 1757 d. 1773 ?
John Frodsham b. 1759
William Frodsham b. ? d. 1805 m. Alice
James Frodsham b. 1761 d. 1761
George Frodsham b. 1762? d. 1819
William James Frodsham see separate family tree Appendix III
John Frodsham b. 1781 d. 7.5.1849 m. Jane b. 1789 d. 22.5.1861
Mary Frodsham b. 1790 d. 17.1.1865
Alice Frodsham b. 1796 d. 1866 see separate family tree Appendix II
Edward Frodsham b. 1797 drowned at sea
Mary Frodsham b. ? d. ? m. Richard Tewkesbury Channon ? Chaucer ?
Henry John Frodsham b. 1809 d. 18.2.1848 m. Emma b. 1813 d. 12.6.1861
Jane Frodsham
John Frodsham b. 1818?
Alice Frodsham
George Edward Frodsham b. 1831 d. 1903 m. Elizabeth Mayhew Frost 1861 b. 1828 d. June 1905 no issue
Henry Dodd Frodsham of Bournemouth d. 2.11.1906 m. Marienne Emma
Henry Frodsham
Arthur Frodsham
Cecil Frodsham
Sidney Herbert Frodsham d. 21.4.48
Percy Nugent Frodsham 29.1.64
Stanley Howard Frodsham

33 Gracechurch Street

By 1825, John Frodsham had moved his business to the above address. The firm was now well established and was making good quality watches and chronometers, both pocket and marine. In 1837 he moved to 31 Gracechurch Street.

In 1826, whilst at Gracechurch Street, he accepted Thomas Carter as an apprentice for 7 years. £4. Dixon charity. Carter's father was a waiter.

In 1830 John was elected to the livery of the Clockmakers' Company. He had married in about 1808 and his wife, Jane, gave birth to three children :—

Henry John Frodsham, born in 1809. He was apprenticed to his father on the 3rd May, 1830, and was made a Freeman of the Clockmakers' Company on the 8th January, 1838. He became his father's partner in 1834 and the firm's name changed to **" John Frodsham & Son "**, but unfortunately he died on the 18th of February, 1848, i.e., during his father's lifetime.

John Frodsham, junior, born in about 1818 and apprenticed to his father on the 13th December, 1832. He is not shown Free, and it seems likely that he died whilst still young.

George Edward Frodsham, born in 1831. He would appear to have worked for his father although not officially apprenticed to him. He married Elizabeth Mayhew Frost on 14th February, 1861, but they had no children. When his brother, Henry John, died in February, 1848, George Edward must have taken his place as a partner in the firm and we find that when his father, John, senior, died in May, 1849, George Edward, aged only 18, took charge of the business. The Post Office directories tell us that the name of the firm was maintained as **" John Frodsham & Son "** until 1853. However, in 1854 it changed to **" Frodsham Son & Co."**, changing again in 1855 to :—

" Frodsham & Baker ", 31 Gracechurch Street, 1854 - 1863

The " & Co." suggests that Baker had joined the firm in 1853, becoming a partner in 1854. The firm retained this title until 1863.

Who then was this " Baker ", and who was the " Baker " who was a partner for a year in 1808 ? There is a small mystery here and so far I have not been able even to hazard a guess as to the name of the 1808 Baker, though it would seem likely that he was related to the later Baker of 1854. The 1854 - 63 Baker could, I feel, have been the Edward Baker of 6 Angel Terrace, Pentonville, who submitted chronometers for the Greenwich Trials between the years 1822 and 1834. My reason for believing this is that these same chronometers were later sent to Frodsham & Baker for overhaul when necessary, as shown in the Greenwich Records.

" George E. Frodsham ", 1864 - 1901

This became the title of the firm in 1864 and their business premises still continued to be 31 Gracechurch Street.

By 1889 the firm had become a Limited Company; their catalogue of this date gives us a little more information. It states that the firm was established in 1796, and that in 1889 they were Clock-makers to Her Majesty the Queen, H.R.H. The Prince of Wales, The Lords of the Admiralty, The Royal Observatory, Indian and Colonial Governments, Chinese Maritime Customs, etc.

They had been awarded a Medal at the International Exhibition in Paris in 1878, and a Medal at the International Inventions Exhibition in London in 1885.

The catalogue states that no foreign watches of any description were kept in stock, and that every watch was made under their direct supervision.

Prices

Gold English keyless minute and split seconds chronograph, chronometer sprung double roller escapement and compensated balance. £125.

Gold English Keyless Minute Repeater. £100.

Gold English Keyless Pocket Chronometer. £75.

2-day Marine, £25-28. With auxiliary for extremes of temperature. £30 - £35.

8-day Marine, £40-£43. With auxiliary for extremes of temperature. £45 - £50.

The above have " G. E. Frodsham, London " on their dials.

8-day English Regulators. Plain Case. Mercurial Pendulum. £40.

8-day English Regulators. Heavy Ornate Case. Heavy Mercurial Pendulum. £75.

They also sold turret clocks.

Watch manufacture

Some of the less expensive watches were machine-made, being manufactured by The British Watch and Clock Making Company. The lay-out of these watches is quite distinctive. As can be seen in **Plate 3** (page 346) the back plate has a raised central portion to take the centre wheel, thereby allowing the rest of the movement to be slimmer. The plate is cut away to take the click for the stop work which is situated on the top of the going barrel. See page 145 of *Horological Journal* for May, 1890, and the article in *Antiquarian Horology*, by R. F. and R. W. Carrington, page 712 for 1978.

No. 6019 is a typical example of this machine-made type of watch. **Plate 14** (page 354) illustrates No. 6950, the more common hand-finished type.

In October, 1899, J. R. Furneaux (on behalf of Charles Frodsham & Co.) was negotiating with Mr. H. Larard (on behalf of G. E. Frodsham & Co.) with a view to the purchase of G. E. Frodsham's business, but by December, 1899, these negotiations had fallen through.

George Edward Frodsham died on November 10th, 1903, at Brightlingsea, Essex (not far from Colchester). His death certificate tells us that he was an annuitant aged 73, and that the cause of his death was " Hemiplegia and old age ".

He probably had a stroke in about 1899, leaving him paralysed on one side of his body and, possibly, with the inability to speak, which could explain the absence of any Will.

So much then for the original side of the firm which had opened a shop in Kingsgate Street in 1796 and had later moved to Gracechurch Street staying there until 1901. There is no mention of the firm in the Post Office directories after this date.

CHAPTER IV

PARKINSON & FRODSHAM

Part 1

Of all the Frodsham firms of chronometer makers two were outstanding, one was the firm of Parkinson & Frodsham, and the other, the firm of Charles Frodsham. We come now to the first of these. Who then were Parkinson and his partner Frodsham? The former was William Parkinson and the latter, William James Frodsham.

William Parkinson

Very little is known about him. He would appear to have come from a clockmaking family who lived in Lancaster, his father being also William. The younger William may have worked for a time at Prescott before he came to London; it is possible that he could have been the maker of a repeating chronometer signed *Parkinson, London*, but this cannot be proved.

He was made free of the Clockmakers' Company in 1802, and died about 1842.

William James Frodsham

He was born on the 25th July, 1779, and was the eldest son of William Frodsham (The Younger). His grandfather, William Frodsham (The Elder), had already, during his lifetime, given William James " his full share of the property ", so that it may be assumed that he was well provided for. **Plate 5**, page 348.

When he was 20 he married Hannah Lambert of Yorkshire in the year 1799, when she was 23.

In 1801, at the age of 23, he became William Parkinson's partner, and so the famous firm of **Parkinson & Frodsham** was founded at **4 Change Alley, Cornhill.** They decided, very wisely, to specialise in chronometers (pocket and marine), and their choice of Change Alley was most opportune since it was an area frequented by master

mariners, merchants and shippers who came to the local coffee houses, such as Garroway's, to refresh themselves and to conduct their business. Parkinson & Frodsham soon developed an extensive export trade, chiefly in Northern Europe, in addition to supplying the Admiralty and a number of shipping companies.

On October 11th, 1802, the Clockmakers' Company admitted William James as a Free Clockmaker, and in later years he was closely connected with the Company, being chosen on the Court of Assistants on the 12th January, 1824, filling the office of Warden from 1833 to 1835, and then on September 29th, 1836, he was elected Master of the Company, being re-elected Master on September 29th, 1837. He also became a Fellow of the Royal Society.

William James and Hannah had ten children, of whom six were to become watchmakers, four being apprenticed to their father, these four being, Henry, William Edward, Charles and John, the other two being, George and William (the second).

Apprentices

In addition to his four sons, William James had two more apprentices :—

James Thomas Hall, the son of James Hall, a chronometer maker living at 7 Church Street, Trinity Square. 5s. 7years. 1833.

John Blunt, the son of John Blunt, a watchmaker of 12 Salisbury Street, New North Road, Hoxton. 5s. 7 years. 1838.

In 1830 William James took up residence at No. 7 Chatham Place, Hackney, making this his home until his death on the 29th June, 1850. He was buried in Pratt Street Burial Ground, Camden Town, which was used by the church of St. Martin-in-the-Fields. Hannah continued to reside at 7 Chatham Place until her death on the 29th July, 1857. By then, Pratt Street Burial Ground had been closed, and so she was buried in a vault at Highgate Cemetery, her husband's body being removed from Pratt Street and re-interred in the vault at Highgate.

We must now return to the story of the business side of the firm of Parkinson & Frodsham.

Activities of the Firm

In 1801, owing to the success of the Arnolds and of Earnshaw,

there was a great demand for reliable chronometers, both marine and pocket, and Parkinson & Frodsham were quick to seize this golden opportunity to establish themselves as first-class manufacturers. To do this they obtained permission to send some of their chronometers to be used on trial in some of the early surveying expeditions. William James Frodsham wrote several articles in praise of these machines, and these articles were published in the name of the firm. It would seem that it was largely due to William James that the firm came to the forefront in the chronometer-making world. These booklets provide us with much information concerning the chronometers used in these expeditions.

The first booklet was entitled *A Brief Account of the Chronometer, with remarks on those furnished by Parkinson & Frodsham to the Expeditions of Captains' Ross, Parry, Sabine, King, Lyon, Foster and other distinguished navigators, With the Rate of others tried at the Royal Observatory, Greenwich, in the Years 1828 - 29 - 30-31.* It was published in 1832 by Parkinson & Frodsham, who gave their addresses as Change Alley, Cornhill, Opposite the South Gate, Royal Exchange, London, and 54 Castle Street, Liverpool.

The following is a brief description of these expeditions :—

The North West Passage into the Pacific Ocean

In 1616 Baffin had discovered a bay (which was given his name), situated to the north of Davis Strait. This discovery had been treated with some scepticism until it was confirmed 200 years later by Captain Ross.

1818

Captain John Ross in the *Isabella*, with **Lieut. William Edward Parry**, as his second-in-command, in the *Alexander*, with John Ross' nephew, James Clark Ross, as midshipman, were sent to Davis Strait. **Captain Sabine**, of the Royal Artillery, F.R.S., had been appointed Astronomer to the expedition. They found Baffin Bay, and then, when they were opposite Lancaster Sound, at the far end of the bay, Ross thought he saw high land blocking the way, whereas Parry thought he could see a passage; unfortunately for Ross, as we shall see, he was wrong. See map **Plate 4**, page 347.

A number of chronometers were taken with them, as follows:—

Parkinson & Frodsham No. 228. The firm had obtained permission for this chronometer to be sent on trial with the expedition, and, as a result of its excellent performance, it was, in due course, purchased by Mr. Croker, Secretary to the Lords of the Admiralty.

The other chronometers sent on this expedition were :—

Earnshaw, No. 815 — Furnished by the Admiralty.
Arnold, No. 369 and 2151 — Furnished by the Admiralty.
Earnshaw, No. 1024 — The property of Captain Ross.
Arnold, No. 25 — The property of Henry Browne, Esq.
Arnold, No. 523 — Under the charge of Captain Sabine.

1819

In view of the above difference of opinion, the Admiralty organised a second expedition, this time under the command of **Lieut. W. E. Parry** in the *Hecla*, with **Lieut. Liddon** in the *Griper*. **Captain Sabine** again accompanied this expedition as Astronomer. Sailing up Baffin Bay they made their way to Lancaster Sound, which Ross had believed to be closed by mountains. Parry succeeded in proving that it was in fact a strait, and sailed on through it to reach 112° west of Greenwich, thereby winning the reward of £5,000 offered by the Government for ships passing the 110th meridian. Parry was prevented from sailing any further west by the heavy pack ice although he could see that there was a passage, and he considered that no sailing vessel would ever be able to make the passage through this strait, in which belief he was quite correct. The two ships succeeded in spending the winter frozen in Arctic ice at Melville Island.

Parkinson & Frodsham had obtained permission to send three more chronometers for trial on this expedition, as well as No. 228.

No. 259, under the care of Lieut. Parry.

Nos. 253 and 254 under the care of Captain Sabine.

All four performed remarkably well in spite of spending the arctic winter on board the ships when they were exposed to temperatures of 40° below zero.

Ten other chronometers were on board these vessels and all ten actually stopped at times. Eight of these ten were made by Arnold

they were, Nos. 25, 367, 369, 377, 404, 497, 523, all box chronometers, and No. 2109, a pocket chronometer. Parkinson & Frodsham Nos. 253 and 254 were later purchased by the Lords of the Admiralty.

No. 259 was purchased by the officers of the expedition and presented to " Captain " Parry as a testimony of the esteem and respect they entertained for their commander.

Shortly after this expedition Molyneux tried to claim that he had been the maker of these four Parkinson & Frodsham chronometers whereas in fact he had never even seen them. Molyneux had introduced a Mr. Hopkins to Parkinson & Frodsham and it was Hopkins who had sprung the chronometers. Unfortunately Parkinson & Frodsham gave Molyneux the money to pay Hopkins. Needless to say the chronometers were finished by Parkinson & Frodsham. (Board of Longitude, Vol. XIX, part 2, page 383.)

1821

Another expedition was organised again under the command of **Captain Parry**, this time aboard the *Fury*, with **Captain Lyon** in the *Hecla*. Parry now attempted to find a passage nearer to the Canadian mainland and reached Winter Island and Igoolik, but the pack ice again proved to be impenetrable. He took the following chronometers on this expedition:—

Parkinson & Frodsham, Nos. 228, 253, 254, 259, 460, all 2-day chronometers, and No. 458, an 8-day chronometer.

Arnold, Nos. 326 and 369, marine chronometers, and Nos. 14, 1897 and 2109, which were pocket chronometers.

Molyneux & Cope, No. 405.

Finer & Nowland, No. 281, an 8-day chronometer.

1824

Captain Lyon in the *Griper*, with **Lieut. Kendall** as assistant surveyor, sailed to Repulse Bay, but failed to discover a North West passage. Parkinson & Frodsham sent two chronometers on this expedition, one of which was :—

W. E. Frodsham, No. 1. (W. E. Frodsham being one of William James' sons.)

1824

This was **Captain Parry's** third voyage. He was in command of the *Hecla*, with **Captain Hopner** in the *Fury*. Once again the pack ice proved to be impenetrable, and, much to their dismay, the *Fury* was driven ashore by the ice in Prince Regent Inlet and had to be abandoned. **Mr. Foster** accompanied the expedition as Astronomer and was in charge of all the chronometers, which included :—

Parkinson & Frodsham, No. 228, and pocket No. 423, both Government property

No. 259, belonging to Captain Parry

No. 510, a pocket chronometer belonging to Lieut. Wynne.

Plate 12, page 354.

Henry Frodsham, No. 1. (Henry being another of William James's sons.) This particular chronometer performed equally as well as any of the others and was adopted, in 1825, as the Standard Chronometer, and, on the return of the expedition, it was purchased by Lord Melville (whose father had been the First Lord of the Admiralty) for his son, Captain the Hon. Richard Dundas.

The other chronometers were :—

Arnold, No. 2 (belonging to Arnold) and a pocket chronometer No. 2109, the property of the Government.

Murray, No. 518 (belonging to Murray) and No. 816, Government property.

Lancaster, Nos. 552 and 566, both Government property.

All the above were on board the *Hecla*, the following being in the *Fury* :—

Arnold, No. 217. Government property.

Parkinson & Frodsham, Nos. 254 and 649, both Government property.

Smith, No. 27. Also Government property.

Expedition to try to reach the North Pole

1827

This was **Captain Parry's** last voyage in the *Hecla*, again with **Lieut. Foster** as Astronomer. Their object was to attempt to reach the North Pole by using boats as sledges over the drifting ice, at

the same time taking advantage of water whenever possible. They managed to reach 82° 45′ North, and this was the nearest point to the Pole that anyone was to reach for the next 50 years.

Six Parkinson & Frodsham pocket chronometers were taken on the voyage. They were:—

Nos. 699, 701, 741, 799, 948 and 980, two of which had been specially prepared by Parkinson & Frodsham, being given 24-hour dials, with the idea that the possibility of incurring an error of 12 hours would be avoided when travelling over the ice towards the Pole.

Sabine's Pendulum Experiments to measure the shape of the Earth
1822

Captain Edward Sabine was taken by **Captain Clavering** in the *Iphigenia* to Sierra Leone on the West Coast of Africa with the intention of making experiments to determine the figure of the earth by means of a pendulum vibrating seconds in different latitudes. The following chronometers were used on this expedition :—

Parkinson & Frodsham, Nos. 357, 384, 423 and 493. Captain Sabine said afterwards that Nos. 357 and 423 were the best he had known.

1823

Captain Sabine now proposed to continue his experiments in higher latitudes, and therefore he was taken to Spitzbergen by **Captain Clavering**, this time on board the *Griper*. The same Parkinson & Frodsham chronometers were used, i.e.:—

Parkinson & Frodsham, Nos. 357, 384, 423 and 493, plus W. E. Frodsham, No. 1. They all performed well although No. 423 was found to have the least variation of any of the chronometers.

1828

Captain Foster, in the *Chanticleer*, with **Lieut. Kendall** in charge of 17 chronometers for a portion of the voyage, sailed to a number of places including Cape Horn and the Cape of Good Hope, in order to make pendulum experiments and extensive surveys.

Unfortunately Captain Foster was drowned on the return journey. Of the 17 chronometers taken on the voyage, two were :—

Parkinson & Frodsham, No. 543, a pocket chronometer worn by Captain Foster when he was drowned.

Parkinson & Frodsham, No. 1204, which was, in due course, adopted as the Standard Chronometer until the end of the voyage in 1831.

The following chronometers belonging to the Government were sent on this expedition :—

French, No. 4214. Dent, No. 2. McCabe, Nos. 167 and 187. Arnold, No. 570. Parkinson & Frodsham, Nos. 699, 799, 902 and 1095. Young, No. 78. Murray, Nos. 555 and 620.

South American Surveying Expedition
1826

Captain King in the *Adventure* and **Captain Stokes** in the *Beagle* set sail in order to survey Terra del Fuego, Magellan Straits, Cape Horn, etc.

Thirteen chronometers were sent with this expedition, of which Parkinson & Frodsham, No. 1048 was found by Captain King to be the best.

The other chronometers were, French, Nos. 3227, 3233, 3271, 3290, 3292, 3293, 3294, 3295 and 3296, and Parkinson & Frodsham, Nos. 228 and 254, and McCabe & Strachan, No. 134.

Parkinson & Frodsham Chronometers used in other voyages

No. 276 was purchased in 1822 by **Captain Lodowick Leeds** of the *Isabella* of Baltimore, and used in 1824 on voyages to China and America.

No. 560 was used by **Captain George Probyn** of the Hon. East India Company's ship *Minerva* in 1823.

No. 594 was purchased in 1823 by **Captain Dewson** of the Boston Packet Ship *Topaz*.

Nos. 145 and 146. These were 8-day chronometers belonging to **Captain John Clarkson** of the *Bombay Merchant*, and used by him prior to 1828.

No. 771 was purchased by **Captain Hugh Graham** of the Packet Ship *Caledonia* in 1822.

No. 1152 was used by **Captain F. H. Hebard** of the Packet Ship *Hannibal* prior to 1832.

No. 729 was used by **Captain Joseph Pinder** of the East India Ship *Hindoo* in a voyage to Calcutta in 1831.

No. 564 was purchased in 1826 by **Captain William Rowett** and used by him in four voyages round Cape Horn.

No. 980 went with **Sir John Franklin** in 1845 on the last voyage of the *Erebus*. It was found in 1859 amongst Sir John's relics.

No. 2110 went on board the *Rescue* in the Grinell Expedition in search of Franklin in 1851.

No. 2131 went on board the *Advance* in the Grinell Expedition.

Parkinson & Frodsham Pocket Chronometers Valencia

In 1844 the following pocket chronometers were used for the estimation of the longitude of Valencia (see *Dent*, page 218) :—

Nos. 251, 699, 750, 1230, 2310, 2312 and 2709.

Free-Sprung ?

One point of interest; some of the earlier pocket chronometers were not free-sprung, for example Nos. 307 and 324, both of which have regulators as well as compensation balances. **Plate 10,** page 353.

Eight-day Pocket Chronometers

The firm experimented in about 1819 with the manufacture of an 8-day pocket chronometer. No. 620 is the only example known at present. It is unusual in having a plain steel balance with a compensation curb, and it is free-sprung. It has an intermediate wheel between the fusee and the centre wheel, and therefore it has a reversed fusee.

Another Parkinson & Frodsham Booklet

Another interesting booklet concerning Parkinson & Frodsham published in 1834, was entitled *Observations on Chronometers from the Appendix to Captain Sir John Ross's Narrative of his Second Expedition to The Arctic Regions from 1829 to 1833.* The story of this expedition is interesting.

North West Passage
1829

John Ross was then 53 years of age. Having made an error in thinking that there was no passage at the west end of Baffin Bay, he was anxious to undertake another expedition. He managed to raise sufficient money for a private venture. His ship, the *Victory*, was only 85 tons, and a poor vessel at that. His nephew, **James Clark Ross**, was one of the 16 members of his crew. Following Parry's route down Prince Regent Inlet they wintered their ship 200 miles south of the wreck of the *Fury*. Unfortunately the *Victory* became so frozen in that in spite of waiting for three summers they were still unable to sail. James Ross made several sledge journeys during these three years and in 1831 he succeeded in reaching the North Magnetic Pole which was situated at approximately 71° North 96° West. In 1832 the crew abandoned the *Victory* and sledged 200 miles north to the wreck of the *Fury*. After patching-up the old boats belonging to the *Fury* they had to spend a very cold winter on the beach, but in the summer of 1833 they were able to use their boats and managed to reach Lancaster Sound, where they were picked up by a whaler. They had in fact been given up for lost. In spite of the terrible conditions only two of Ross's crew failed to return.

Of the five chronometers taken on this expedition, two were made by Parkinson & Frodsham. Pocket Chronometer No. 1081, which had been used by **Sir William Edward Parry** for his attempt to reach the North Pole, and Marine Chronometer No. 571.

Sir John Ross was so delighted with the performance of the Parkinson & Frodsham chronometers that he wished the firm to make public the principle on which these instruments had been brought to such perfection, and so he wrote to Parkinson & Frodsham who replied on the 15th May, 1834, to say :—

> We have no hesitation in complying with your wishes so far as is consistent with justice to ourselves, and we hope that our communication may prove useful.

They do not, however, tell us anything about this principle, but, towards the end of their seven-page letter they say :—

We are willing to give up to the public the benefit of our knowledge and experience in these matters, on receiving, as others have done, an adequate compensation for the value which the discovery is of to us in our private business; but we hold ourselves justified in withholding an explanation of the principle, until it either ceases to be of importance to us, or we are adequately remunerated for disclosing it.

The most interesting part of this letter concerns Parkinson & Frodsham's claims to have made certain chronometers which were entered for Greenwich Trials. They say :—

We may also be allowed to state, that on this trial (1833), 60 chronometers were sent by various makers; and at the termination, the numbers were reduced to 10, four of which were made by us; and the extreme variation of each, in the 12 months, was considerably within the limits fixed in 1828 for the reward of Three Hundred Pounds. Three of them made less error than our chronometer, No. 1410, in 1828; for which we then received the premium of Three Hundred Pounds. The extreme variations of these five chronometers were as follows :—

In 1828, No. 1410 in twelve months 1m.41s. actual extreme variation.

1833	679	ditto	0.98
	1600	ditto	1.31
	460	ditto	1.24
	1502	ditto	1.52

However, an examination of the trial records will show that these chronometers were not all entered in the name of either Frodsham or Parkinson & Frodsham. As follows:—

No. 1410	was entered in the name of		*Guy.*
679	,,	,,	*Richard Webster, 43 Cornhill.*
1600	,,	,,	*H. Frodsham, Change Alley.*
460	,,	,,	*Thomas Cotterell, 163 Oxford St.*
1502	,,	,,	*H. Frodsham, Change Alley.*

The letter continues as follows :—

In 1830, one of our chronometers was entitled to the second prize, and some others of our making were within the limits.

In the trial of 1831, the chronometers made by us obtained the whole of the three prizes, and another was fifth on the trial list. We may be excused for making particular reference to the trials of this year, from the remarkable circumstances, that in all the preceding years, from 1822, when the trials for prizes were first established, a period in which several hundreds of chronometers had been sent for trial, but four had performed within one second of extreme variation in the twelve months; whilst in this trial the whole of our four chronometers went within less than a second of extreme variation; the following being the extreme variations as published by the Astronomer Royal;

No. 311	in twelve months	0.70s. actual extreme variation.
2	ditto	0.86
665	ditto	0.89
1	ditto	0.99

On examining the names entered in the trial records we find :—

No. 311	was entered in the name of		*T. Cotterell.*
2	,,	,,	*C. Frodsham.*
665	,,	,,	*R. Webster.*
1	,,	,,	*C. Frodsham.*

It would therefore appear that those chronometers entered in the names of Webster and Cotterell were actually manufactured by Parkinson & Frodsham or by one of the Frodshams.

As a proof of this it is most interesting to find that a marine chronometer, with the name " Richard Webster, Cornhill, London. No. 728 " engraved on the silvered dial, has the name " Parkinson & Frodsham, Change Alley, London. " on the back plate, but no number.

In the 1833 Trial, Webster submitted Nos. 679 and 700, one of which was awarded the 3rd Premium, but it was discovered that this chronometer bore the partly erased name of Frodsham on the back plate and so it was disqualified and Molyneux No. 1263 was then given the 3rd Premium.

In *Edward John Dent*, page 37, it is pointed out that in 1833 the declaration which all those persons who wished to submit chronometers for trial had to make, was altered to read:

> I declare that the Chronometer or Chronometers which I have now deposited at the Royal Observatory, and opposite to the distinguishing numbers of which I have affixed my name, is, or are my own construction, and that no other maker's name is or has been engraved on any part thereof.

In this way another loophole was closed, and it was hoped that the actual maker would receive the credit for having made the chronometer, but, as seen on pages 77 and 78 of the same book, some makers appear to have found a way out of this closed loophole.

One other point of interest; it seems, from the above, that all the Frodshams were using the same principle in the manufacture of their chronometers.

With regard to the Admiralty Trials, William James Frodsham is believed to have been responsible for the stopping of an abuse at Greenwich. Makers submitting chronometers for trial were more or less blackmailed by the staff into paying approximately £10 per machine for its maintenance whilst undergoing trial. William James Frodsham objected and in due course the Admiralty took the necessary steps to stop this abuse.

The Change in Rates in Chronometers

In May, 1833, an article was published in the *Nautical Magazine* written by Arnold & Dent, it was entitled *Magnetic Experiments on Chronometers*. The authors claimed that the presence of large masses of iron on board a ship would have an affect on the rate of any chronometer which the ship was carrying. Doubting the truth of these assertions, Parkinson & Frodsham decided to repeat some of the experiments. They took four of their own chronometers, Nos. 745, 776, 925 and 1978, and ascertained their rates in Change Alley, they then carried the chronometers to their residence, about three miles away, and again found their rates. After this they were carried round the Royal Exchange for about half an hour every morning for several days, and, following after this they were placed in an iron chest for the same period. There appeared to be no

consistent variation. In August, 1833, having observed their rates in London they sent chronometers Nos. 1731 and 1751 to be rated at Greenwich and there appeared to be very little change of rate resulting from their removal from London to Greenwich. These results, which were written on the 14th November, 1833, were published in the *Nautical Magazine.* They also pointed out that Captain Sabine, in his work on the figure of the earth, page 391, said, " amongst the many with which I have at different times been furnished by Messrs. Parkinson & Frodsham, and which I have frequently transferred from the ship to the shore, for two or three weeks at a time, for the purpose of trial, I have never been able to discover any systemic variation whatsoever consequent on their removal ". Captain Sabine did not believe that the magnetic influence of iron had any effect on the rates of chronometers, and said that this was proved by the record of the behaviour of four Parkinson & Frodsham chronometers as given in his account in the Appendix to Captain Parry's *Voyage of Discovery* in 1819 and 1820, pages 7, 12, 18, 19 and 20. Again quoting Captain Sabine, " On the arrival of the Hecla in the Thames, the chronometers were returned to Messrs. P. and F's house in London, when, after a month's interval, they were found to be still going at the same rate as in the Hecla whilst in the harbour of Melville Island ".

They concluded their article by saying, " That a material effect on the going of a Chronometer would be produced by applying a powerful magnet to it, we have no doubt. Our object in writing to you on this occasion, is to convince those whom it chiefly concerns, that the errors, and causes of errors, on which your respectable Correspondents have animadverted, cannot in the present state of Chronometrical Science have any appreciable effect in practice." The above article was reprinted as a booklet.

Apparently **Mr. W. C. Bond**, of Boston in America, had taken great pains to ascertain whether there is any tendency for chronometers to change their rates when put on ship-board. His method was to take the rate before and after a voyage. One is therefore left to assume that the rate on board the ship did not differ. The following is the list of 87 chronometers made by Parkinson & Frodsham.

No. of Chron.	Difference of Rate.	No. of Days at Sea.	No. of Chron.	Difference of Rate.	No. of Days at Sea.	No. of Chron.	Difference of Rate.	No. of Days at Sea.
875	+ 0·4	96	752	+ 0·7	59	1100	+ 0·5	48
928	0·0	56	549	− 0·1	388	832	+ 0·3	66
427	− 0·6	167	1035	+ 0·9	.....	1047	− 0·3	231
920	+ 0·2	153	905	− 0·6	54	1142	+ 0·3	58
966	− 0·3	46	871	− 0·4	200	1184	− 0·1	29
873	+ 0·8	53	1061	− 1·0	61	981	− 0·5	95
981	+ 0·4	55	1090	+ 0·1	109	1170	+ 0·1	36
1030	− 0·7	64	919	+ 0·1	47	1006	− 1·0	37
920	+ 0·7	157	981	+ 0·3	113	613	− 0·5	176
534	− 0·1	63	125	− 0·2	Pacif.	430	− 0·1	313
871	+ 0·2	186			Ocean.	871	+ 0·7	89
919	− 0·5	.....	.....	+ 0·0	.....	866	− 0·4	101
684	+ 0·3	.....	727	+ 0·4	28	832	+ 0·5	114
889	+ 0·1	.....	1030	− 0·7	57	1122	− 0·9	95
1056	− 0·4	52	549	− 0·6	169	.....	0·0	53
669	− 0·5	294	669	+ 0·5	45	609	+ 0·3	220
704	+ 0·3	62	.....	− 0·7	187	966	− 0·3	120
832	+ 0·7	59	.....	− 0·3	338	1091	− 0·6	77
1091	+ 0·6	50	.....	− 0·5	294	873	0·0	27
1079	− 0·8	50	.....	− 1·0	143	1030	+ 0·3	177
891	− 0·3	161	811	+ 0·5	136	1146	− 0·4	47
928	− 0·7	65	534	− 0·6	26	1179	0·0	55
928	− 0·7	90	1144	+ 0·5	44	1100	0·0	55
599	− 0·8	56	1053	0·0	61	1210	+ 0·3	47
508	+ 0·1	677	1246	+ 0·3	61	1242	− 0·7	47
981	+ 0·2	146	966	− 0·6	112	635	+ 0·3	102
521	+ 0·3	74	1184	+ 0·2	68	1100	− 0·2	57
947	− 1·0	254	1068	+ 0·2	60	1215	+ 0·7	57
599	+ 0·1	84	901	0·0	50	1030	− 0·3	202*
873	0·0	95						

*70 tons of iron on board.

Summary.

	No. of Chron.	No. of Days at Sea.
Number of Trials	87	
Number wherein the average shore rate differed from the ship-board rate—and the difference		
Number wherein the difference was One second	4	37 to 254
Ditto wherein the ditto was 9-10ths of a second	2	— to 95
Ditto .... ditto ... 8-10ths ditto ...	3	50 to 56
Ditto .... ditto ... 7-10ths ditto ...	11	47 to 157
Ditto .... ditto ... 6-10ths ditto ...	7	27 to 169
Ditto .... ditto ... 5-10ths ditto ...	10	44 to 294
Ditto .... ditto .. 4-10ths ditto ...	7	28 to 200
Ditto .... ditto ... 3-10ths ditto ...	17	46 to 338
Ditto .... ditto ... 2-10ths ditto ...	8	57 to 286
Ditto .... ditto ... 1-10th ditto ...	9	25 to 677
Number wherein there was no difference whatever	9	27 to 95

It is evident from these experiments that there is no general tendency in these Chronometers either to gain or lose at sea, on their land rates; as it appears from the above, that, out of eighty-seven trials, thirty-nine gained on their rates, and thirty-nine lost on their rates: the remaining nine made no variation whatever.

Exports

In addition to supplying the Admiralty and shipping companies with a large number of chronometers, mostly of the marine type, the firm was also sending a number of marine chronometers to the United States of America, and, commencing in 1834 and continuing until 1865, they sent at least 139 chronometers, many of which were for use in the U.S. Navy (as shown in the *Bond Papers*).

The *" Bond Papers "* are in three volumes. Volume 1 has records of various chronometers in the hands of the firm of William Bond & Son of Boston (agents), during the years 1833 - 1835. Volume 2, deals with chronometers from 1848 - 1855. Volume 3, has Parkinson & Frodsham records from 1856 - 1871. Copies of these records can be found at Greenwich.

Vibrations of Pendulums

On June 21st, 1838, W. J. Frodsham, F.R.S., read a paper before the Royal Society. This concerned the effect on the arc of vibration of a pendulum, produced by using different thicknesses of suspension spring, different lengths of spring and different weights of maintaining power.

He chose a pendulum having a 14lb. lenticular bob with a cylindrical rod passing through it, with a nut working on a screw at the lower end and supporting the bob. The upper end of the rod was slit to receive the spring, and the spring and the rod were attached to each other by a pin passing through a hole in both. Before fixing this pin, however, he slid a piece of brass tube five inches long onto the rod. The lower inch of this brass tube was slit to form a spring to enable the tube to bite firmly on the rod, and then, by means of a clip at the upper end of the tube, the effective length of the suspension spring could be varied. He called this tube his " isochronal piece ".

He experimented with, first of all, two silken threads, one behind the other, and five dimensions of spring as follows :—

Number	Breadth	Thickness
1.	.350 inch	.001 inch
2.	.390	.002
3.	.395	.003
4.	.395	.004
5.	.400	.005

Using the silken threads and leaving the pendulum to vibrate by its own gravity, he found that :—

The arc of vibration was reduced from 2° to 1° in 20m. 37s.
and from 1° to ½° in 23m. 12s.

He then applied maintaining power weighing 6lb 8oz., but the clock stopped in 39mins., but on applying a weight 3oz. heavier, i.e., 6lb. 11oz., he found that this was sufficient to keep the pendulum vibrating, but with rather a small arc of vibration.

Heavier weights were therefore applied and the clock's rate observed :—

Weight	Arc of Vibration	Rate
19lb. 0oz.	2° 15′	− 13s.
14 6	2 3	− 9.5
11 2	1 45	− 7
8 0	1 30	+ 1

Therefore, using a silken thread, a heavier weight produces a greater arc and a slower rate.

Spring No. 1 (the weakest) was now applied without maintaining power using an effective length of .92 inch, and it was found that:—

The arc was reduced from 2° to 1° in 1hr. 58m.
and from 1° to ½° in 2hr. 9m.

Maintaining power was now applied :—

Weight	Arc	Rate
4lb. 1oz.	2° 3′	− 9s.6
2 2	1 30	− 6 .1

Spring No. 2. No maintaining power. Effective length .92 inch.

The arc was reduced from 2° to 1° in 2hr. 20m.
and from 1° to ½° in 2hr. 26m.

Applying weights :—

Weight	Arc	Rate
4lb. 1oz.	2° 9′	− 0s.2
2 2	1 36	+ 2 .5

Spring No. 3. With maintaining power. Effective length .92 inch.

Weight	Arc	Rate
4lb. 1oz.	2° 15′	− 2s.5
2 2	1 39	− 2 .8

Reducing the effective length to .80 inch.

Weight	Arc	Rate
4lb. 1oz.	2° 9′	− 0s.2
2 2	1 30	− 0 .1

Without maintaining power. Effective length .92 inch.
The arc was reduced from 2° to 1° in 2hr. 25m. 52s.
and from 1° to ½° in 2hr. 37m. 0s.

The experiment was repeated.
With maintaining power. Effective length .92 inch.

Weight	Arc	Rate
4lb. 1oz.	2° 15′	− 4s.5
2 2	1 39	− 4 .7

"Showing that even with different lengths of this spring, the vibration of the pendulum may be considered as isochronous, with considerably different arcs of vibration; and also that with this spring, a greater arc of vibration is produced with the same maintaining power, than with any other spring that has been tried."

Spring No. 4. Without maintaining power. (Effective length not stated ? .97 inch.)

The arc was reduced from 2° to 1° in 1hr. 48m.
and from 1° to ½° in 1hr. 57m.

With maintaining power. Effective length .97 inch.

Weight	Arc	Rate
4lb. 1oz.	2° 6′	− 2s.5
2 2	1 30	+ 1 .2

The rate appears to vary more with the arc of vibration with this comparatively stiff spring, than it did with spring No. 3.

Effective length reduced to .66 inch.

Weight	Arc	Rate
4lb. 1oz.	2° 3′	– 14s.1
2 2	1 27	– 11 .5

Effective length reduced to .50 inch.

Weight	Arc	Rate
4lb. 1oz.	2° 3′	– 18s.0
2 2	1 12	– 14 .5

This further shortening of the spring appears to have had a perceptible effect on the arc of vibration when the lighter weight was applied.

Spring No. 5. With maintaining power. Effective length 1.0 inch.

Weight	Rate
4lb. 13oz.	– 15s.5
2 10	– 13 .5

Effective length .80 inch.

Weight	Rate
6lb. 3oz.	– 14s.6
2 10	– 12 .4

Effective length .50 inch.

Weight	Rate
4lb. 13oz.	– 12s.0
2 10	– 8 .2

A weight of 2lb. 2oz. was not sufficient to keep the pendulum in vibration, but a weight of 2lb. 10oz. was found adequate.

The arc was not noted with this spring, since he found that both No. 5 and No. 4 were too strong for the weight of bob being used, whereas No. 3 seemed to be excellently adapted.

The arc of vibration with spring No. 3 (viz., 2° 15′), using a weight of 4lb. 1oz. required 19lb. weight to produce it when the pendulum was suspended by the silken threads.

To summarise these results

No maintaining power. Effective length of spring .92 inch.

	Arc reduced from 2° to 1°.
Silk threads	20m. 37s.
Spring No. 1.	1h. 58m.
2.	2h. 20m.
3.	2h. 25m. 52s.
4.	1h. 48m.

With maintaining power of 4lb. 1oz. and effective length .92 inch.

Spring No. 1.	Arc 2° 3′
2.	2 9
3.	2 15

W. J. Frodsham concluded his paper by saying:—

It appears then, from the preceeding experiments on suspending springs differing in length and strength, that there is one which, with a given maintaining power, produces a greater arc of vibration than others, and gives the same arc of vibration with a smaller maintaining power; and, further, that with this same spring the vibrations may, in point of time, be all considered as isochronous, whether the arcs are large or small. And with the aid of the isochronal piece, a spring of the proper length and thickness may easily be selected in a very few trials.

It may be noticed, too, that unless a pendulum is first isochronized by some such method as that which has been pointed out, anomalies may be imputed to imperfect compensation, which have their origin in a very different source.

In fine, it may be stated in conclusion, that if the pendulum of astronomical clocks were furnished with what I have called an isochronal piece, any person possessing a few springs of different degrees of strength, may with very little difficulty determine what spring is best adapted to the weight of the pendulum, and also what part of the spring may be most advantageously employed in action; and I shall not think that the attention which I have given to this subject has been misspent, if any thing that I have done may contribute to the advancement of the art, to which I have been professionally devoted during the whole of my life.

Mercurial Pendulum

This is described in the *Encyclopaedia Metropolitana*, Vol. VIII, page 624, published in 1845.

W. J. Frodsham's idea was to do away with the use of a stirrup. The glass vessel (which was elliptical in section) had a hole in the bottom to take an iron tube, the lower end of which was fixed securely in this hole. The top end of the iron tube fitted into a countersink in the cover of the glass vessel. The suspension rod was a cylinder of steel which passed through the hole and was secured above and below the glass vessel by nuts, so that the length of the rod can be altered if necessary.

The first clock made on this principle was ordered by a Mr. Barlow of Woolwich, for the College of Virginia, U.S.A., " agreeable to the wishes of the late venerable President Jefferson, who just lived to see it in its place ". Jefferson died in 1826.

Quick Trains

The firm must have been experimenting with the use of quick trains as early as 1839, since there is just one letter concerning this idea, it is dated July 20th, 1839, written by F. Beaufort to Airy :—

> Messrs. Parkinson & Frodsham have represented to me that the Chronometer 2373 was constructed, for trial in a steamer, with quick vibrations like those of a pocket chronometer, 5 in 2.
>
> I should like therefore to watch its proceedings a little longer if you have no objection.

As we shall see, Charles Frodsham also experimented along these lines in 1843.

Description of the Balances used by Parkinson & Frodsham

In January, 1841, William James Frodsham wrote, on behalf of Parkinson & Frodsham, to G. B. Airy (Astronomer Royal) to say :—

> We are prepared to explain to the Committee the principle of our improvements in the Compensation balance and willing to furnish drawings of the same, as well as to submit for inspection Chronometers with the improvement applied. . . . We have not, by Patent or otherwise, secured to ourselves the advantage of the improvement, preferring in the first instance to offer it to the Government for the advantage of the Public, on such Compensation made to us as the Government might be advised to award.

Airy replied asking that the dawings and explanations be sent as soon as possible.

On February 2nd, 1841, Parkinson & Frodsham sent Airy a letter and drawings of three balances. **Plate 6**, page 349.

1. **The balance in general use** (With no improvements)
The rim of the balance is cut through near the ends of the connecting bar, dividing the balance into two semicircular portions on which the compensating weights A and B are placed in positions which are found experimentally, — a stiff rim requiring the weights to be fixed nearer the loose end of the arc, than a weak one does. At the ends C.C. of the connecting bar are two screws, by screwing which in or out, the rate of the chronometer is altered (diagram No. 1). In our improved form of the balance, now to be described, similar screws are placed to effect the same object.

3. **Four Quadrant balance** (Four equal weights)
By cutting the rim midway between the ends of the bar, as in diagram No. 3, we form it into four quadrants, thus altering entirely the Character of the Balance, and making it more efficient for the purposes of Compensation. Equal weights F.F. are placed at the end of each quadrant, when changes of temperature cause them to recede from, or approach the centre in a direct line, a

condition important to perfect compensation. We adjust for temperature by sliding the weights on the rim; and fastening them to it by tightening screws, till we find the point where the compensation is perfect. If this point is considerably removed from the ends of the quadrant, we change the weights for heavier ones, till perfect compensation is effected with the weights near the ends, as in the diagram.

2. **Quadrant balance** (Two large weights and two small weights) Another form of our improved balance is represented in diagram 2, in which the rim is divided at about 93° from one end of the semicircle, to allow the compensation weights A.A. to stand at the quadrants, or nearly so, the weights in this case being heavier than in the form No. 3.

On the shorter portion of each semicircle we place small screws B.B. as adjusting weights, varying in size, or removing them to different and opposite holes, till the compensation is effected, not disturbing the larger Compensation weights, except occasionally, and then only in small quantity.

The letter goes on to point out the simplicity and effectiveness of these two designs of balance.

Airy's reply is not known, but in his rough notes regarding Eiffe, Molyneux and Parkinson & Frodsham, he wrote:—

Parkinson & Frodsham — one cannot discover anything new in their scheme, — their nature of correction appears founded on mistake.

Robert Molyneux had been granted Patent No. 8418 on the 7th September, 1840, and **John Sweetman Eiffe** had later, in 1842, published his account of *Improvements in Chronometers*, in which he explained his own methods of compensating for the middle temperature error, and also those methods given in Molyneux's Patent.

It would appear, from a letter addressed to G. B. Airy from William James Frodsham on August 11th, 1842, that the latter had been experimenting with a similar device. Frodsham enclosed a

drawing of his device, **Plate 7**, page 350, which consisted of an affix applied on the outer side of the balance rim which would tend to counteract the loss of rate in cold, and the following day Frodsham sent Airy an improved drawing of the same balance. see **Plate 7**, page 350. He explained that he had unexpectedly received a copy of Eiffe and Molyneux's inventions and said " I considered it a duty to my own character immediately to have honourable testimony that I could not have gleaned any information from those inventions, of which I might have been accused, having been, Sir, as you know, previously assailed by evil spirits." He goes on to say :—

> The balance is adjusted by the ordinary means to keep the same time at 50°—55° as at 85°—90°, the chronometer in this condition of the balance would lose considerably in the lower temperatures from the compensation receding too far from the centre; but the steel piece screwed on the outer rim of the balance at the end of the bar, in which there is a screw placed in contact with the outer rim of the balance at 55°—50° acting as a fulcrum or point from which the compensation pieces act in the lower temperature; — permitting them only to recede that distance from the centre of the balance which will make the chronometer keep the same time at 30° as at 55°—90°,—previously adjusted in the ordinary way.

He finished his letter by pointing out that it would be quite easy to apply this affix to any normal balance.

In fact this balance is identical to Poole's balance; it would be interesting to know when Poole first used his balance, which he never bothered to patent. On September 1st, 1842, Airy wrote to W. J. Frodsham :—

> I have carefully considered the plan for the correction of chronometers proposed in your letter of August 11 and 12, and have no doubt that with proper attention (and possibly some modification of mere method of attachment, etc.) it will be successful. As more than one plan has been brought before me

by other persons, I wish you to consider this expression as in no degree conveying my opinion on the comparative merits of different plans.

In the mere mechanical attachment, the following point occurs to me as wanting of attention. The auxiliary arm, which is to check the outspread of the compensation laminae, is held to its mark simply by a screw. Now it seems to me that this may be liable to the following objections,

First that as the strain tending to thrust off the side of the screw's flat head will be considerable, the attachment is hardly firm enough.

Secondly, I know (as a matter of common mechanical experience), that a screw under pressure, which is continually shaken, will in time become unscrewed, and therefore, though your auxiliary piece might remain firm for a day, I doubt whether it would through a winter.

On September 7th, 1842, Airy wrote again to W. J. Frodsham :—

In considering the plan proposed by you for affecting the compensation in chronometers at the low temperatures, it has occured to me to make the following inquiry.

I need not mention that the certainty and the delicacy of any adjustment will depend principally on the space through which the adjusting substance has to be moved from one degree of adjustment to another. Thus if it were necessary to move the screw (whose point acts on the curved lamina) through one turn to make the contact take place at 65° instead of 55°, the adjustment would be very delicate and certain, but if 1/100 part of a turn produced that effect, the adjustment would be difficult.

I wish to know therefore whether, from observation, you can give me the following information : Suppose the screw-point to be in contact at 55°, and you then raise the temperature to 65°, how far must the screw be turned to produce contact again?

On December 20th, 1842, W. J. Frodsham wrote to Airy enclosing the rates of two chronometers tried at Washington, and also the

rates of a chronometer having the affix applied to its balance. He said :—

> I cannot omit at the same time to acknowledge your frank and applicable remarks on the attachment and of the action of the balance on the arm when affixed. Reflecting on some of your remarks I was able to account for some circumstances that appeared strange during some of my previous experiments. I, in consequence, immediately had the arm hardened and tempered to give it strength and elasticity. — I had previously left the steel arm in its natural state. I also made the attachment still firmer and secure.

Death of William Parkinson

It was in about 1842 that William Parkinson died; one wonders just how important he was to the firm. All the booklets appear to have been written by William James Frodsham, and likewise all the letters have been addressed to him, from which it seems fair to assume that he was the leading light in the firm, and that he was not only a keen horologist but also a good businessman who realised that, by lending a number of chronometers for trial at sea in the worst possible conditions, the firm's reputation would be greatly enhanced, especially if these chronometers behaved well. From the numerous letters of recommendation and from the reports given in the booklets, the chronometers would appear to have been, on the whole, excellent in their performance.

Death of William James Frodsham

When William James Frodsham died in 1850 he was a rich man. The following is a summary of his Will :—

Will of William James Frodsham Died 29th June 1850.
Dated 7th August 1848. Proved 19th July 1850

William James Frodsham late of Change Alley, now of Stoke Newington, Middx.

Wife, Hannah	Settlement confirmed. Annuity of £500

Son, Thomas	Sum of £1500
	,, £1000 to be held by the executors
Son, William	,, £3000
Son, George	,, £2500
	,, £1000 to be held by the executors
Son, Charles	,, £3500
Son, Henry	,, £1000
	,, £1500
	Release of all sums due by Henry
Charles	7, Orange Street, Bloomsbury, to such use as Charles shall appoint by deed (now occupied by John Baster)
William	The above during his lifetime
To be sold with the consent of **Emma (his daughter)** and held in trust & invested.	8, Orange Street (occupied by Richard Eaton)
	9, Orange Street (occupied by Henry Hartshorn)
Daughter, Emma	Income of the above for life.
The **4 Children** of **daughter, Eliza**, wife of **William Frost** of Hackney	The above income after Emma's decease
Emma	£3500 to be held in trust for her
The 4 children of Eliza	£1000 to be divided between them
Eliza & 4 children	£3500 to be held in trust
Charlotte Frodsham, widow of **son**, **John Frodsham**	£5000 to be held in trust
Sister, Alice Gorton, widow of **John Gorton**	Annuity of £40
Children of Alice Gorton	£2000 to be divided between them
Sister, Mary Frodsham	£19.19.0
Brother, John Frodsham	£10
Nephews & nieces	£10 each (except Alice Gorton's children)

Edward Bowerbank, Sun Street, Distiller	£150	Trustee.
John Grant, late of Fleet Street, now of London Wall, Chron Maker	£150	Trustee.
Ann Whitaker, 4 York Street, Blackfriars Road,	£10	
and an Annuity of	£12	
Louisa Frodsham, of Gracechurch Street	£19.19.0.	
Louisa Pearce, Louisa Frodsham's niece, an Annuity of	£40	
Thomas Fulton, an old acquaintance (or wife or daughter Ann)	£19.19.0.	
John James Ronaldson, an old acquaintance, of New Broad Street,	£50	
John Blunt, my faithful workman	£60	
Gardener, of Change Alley	£10	
Monicke, my late warehouseman, of Change Alley	£10	
Mrs. Monicke, wife of above an Annuity of	£20	

Charitable Legacies.

The Worshipful Company of Clockmakers to be invested so that the interest be applied in aiding and assisting decayed workmen Freemen of the said Company. To be known as the Parkinson & Frodsham Charity in memory of my late partner William Parkinson.	£1000
Langbourn Ward Charity School, City of London, to be invested	£250
The British Orphan Asylum, to be invested	£250
The Infant Orphan Asylum of Wanstead, Essex, to be invested	£250
The London Orphan Asylum at Clapton, Middx to be invested	£250
The Saint Ann's Society at Brixton, Surrey to be invested	£250
The Society for Aiding Shipwrecked Mariners, Bucklersbury, London	£200
Ball's Pond School, Islington, connected with St. Paul's Parish.	£250

The Fever Hospital, near Battle Bridge. Also to be invested. £200
The Free Hospital, near Clare Market. Also to be invested. £200
King's College Hospital. Also to be invested. £200
Clockmakers Benevolent Institution, founded in 6.3.1815, to be entered in the books as the Legacy of Parkinson & Frodsham. £250

The Residue of his estate to be divided equally between his sons and daughters, but the shares of Thomas, George & Henry to be in trust. Thomas' share to be invested.
Executors to be Edward Bowerbank, John Grant and Charles Frodsham.

However, there seems to have been some disagreement between these executors, because there was printed in the *Gazette* for 1852 an advertisement relating to William James Frodsham concerning a suit in Chancery entitled **Bowerbank v. Frodsham**. Charles Frodsham's family bible gives us the following information :—

In the High Court of Justice. Chancery Division 1815 B No 188
Mr Eustice Fanwell Bowerbank v Frodsham

Details of this law-suit have not been found as yet.

According to the *London Gazette* for January and February, 1852, pages 274 and 349, an Order was made by this Court by which the creditors of William James Frodsham had to leave their claims of debts before The Honourable Sir George Rose (one of the Masters of the Court), before the 29th day of February and such claims had to be established before the 29th day of March, 1852, " or in default thereof they will be peremptorily excluded the benefit of the Order ".

This same family bible was " The exhibit marked J M F 3 referred to in the affidavit of John Mill Frodsham sworn this 3rd day of Feb. 1903

Before me J. O. Gosling A Commissioner & Co.".

but here again there is so far no further information regarding the reason for this affidavit.

Before continuing the story of the firm of Parkinson & Frodsham, it is necessary to know something of the histories of each of William James Frodsham's children. I propose therefore to take up the Parkinson & Frodsham narrative again in a later chapter.

CHAPTER V

THE FAMILY OF WILLIAM JAMES FRODSHAM

Henry Frodsham

The eldest son was born on the 18th December, 1802. On the 13th January, 1823, when he was 21, he was apprenticed to his father, William James, for seven years, for the sum of 5/-.

During and after his apprenticeship he submitted chronometers for trial, his No. 1, as already mentioned, being sent on Captain Parry's third voyage in 1824. A number were submitted for the Greenwich Trials and on each occasion his address was given as Change Alley, as follows :—

May	1825	No. 192 (Pocket)
August	1828	Nos. 873 and 1198
Sept.	1829	Nos. 1381 and 1382
Oct.	1830	Nos. 1381 and 1500
Nov.	1831	Nos. 1502 and 1503
Dec.	1832	Nos. 1502 and 1600
Jan.	1834	Nos. 1829 and 1830

The rest of Henry's life, until his death in 1858, was bound up with business in Liverpool, and this will be discussed in the next chapter.

William Edward Frodsham

The second son of William James Frodsham, born in 1804 and baptised in St. Pancras Church on the 7th August, 1814. He, and his brother, Henry, were apprenticed to their father on the same day, the 13th January, 1823. As we have seen, his marine chronometer No. 1 was used in the 1823 and 1824 voyages of exploration, so that this must have been made at the very beginning of his apprenticeship.

Unfortunately, in 1825, on the 27th July, when he was only twenty, this talented young man was drowned whilst bathing.

However, in 1828, two marine chronometers, Nos. 1 and 2, were entered, in the name of W. Frodsham, for the Greenwich Trials. These must have been made, in my opinion, by William Edward, and submitted for trial either by his father or by his brother Henry. Henry, as we have seen, also submitted two chronometers for this trial.

Eliza Frodsham

The eldest daughter of William James Frodsham, was born on the 29th June, 1806, and baptised in St. Pancras Church on the 8th January, 1812. She married William Frost on the 16th January, 1833, in the Church of St. Paul, Balls Pond Road, now called St. Paul's, Canonbury. They had four children. See **Appendix III**, page 226.

Charles Frodsham, F.R.A.S.

He was born on the 15th April, 1810, and baptised in St. Pancras Church on the 8th January, 1812. He married Elizabeth Mill on the 29th April, 1834. They had nine children. See **Appendix III**, page 230. Charles Frodsham died on the 11th January, 1871, and his wife, Elizabeth, died in July, 1879. They are both buried in Highgate Cemetery (Grave 11678, Square 11). As we shall see in a later chapter, Charles commenced business on his own account in 1834.

John Frodsham

Born on the 21st November, 1811, and baptised in St. Pancras Church on the 8th January, 1812. He was apprenticed, at the age of 14, to his father, on the 9th October, 1826, for seven years, 5/-, and was granted the Freedom of the Clockmakers' Company on the 6th April, 1840. He is said to have worked for Parkinson & Frodsham, but did not apparently become a partner. On the 4th May, 1837, he married Charlotte Dixon. They had five children. See **Appendix III**, page 232.

John Frodsham died on the 17th July, 1844, when he was only 32 years of age, and his wife, Charlotte, died on the 19th October, 1895. They are both buried in the churchyard of St. John's Church, Hackney, in the Dixon vault.

John Frodsham had died intestate and, when administration was granted at last in June, 1903, to his daughter, Charlotte Elizabeth Ohrly, his estate was valued at £1,174.

Mary Anne Frodsham

Another daughter of William James Frodsham. She was born in March, 1813, and baptised in St. Pancras Church in 1814. Died on the 8th November, 1824, aged 11.

George Frodsham

The fifth son of William James Frodsham. He was born in 1816, and baptised on the 13th July, 1817, in St. Pancras Church. On the 16th October, 1841, at the Parish Church, Clapham, he was married to Mary Ann Watson. George died on the 13th July, 1873, and was buried in the cemetery at West Norwood (Grave 3120, Square 62). Mary Ann Frodsham died on the 25th May, 1895. They had eight children, of whom only one was a son, George William Frodsham, born on the 16th May, 1847.

The story of George Frodsham and of his son, George William, and of their connection with the firm of Parkinson & Frodsham, will be developed in a later chapter. For details of the other members of their family see **Appendix III**, page 233.

Emma Frodsham

The youngest daughter of William James Frodsham, was born on the 16th June, 1817, and baptised in St. Pancras Church on the 13th July, 1817. She married Walter Rennick on the 30th December, 1848. Walter died on the 9th January, 1880. Emma died on the 6th January, 1901. They are both buried at Worcester. No issue.

William Frodsham

He was born on the 16th February, 1819, and died at the age of 81, on the 21st May, 1901, and was buried at Uplyme in Devonshire. Although not apprenticed to his father, he appears to have learnt the art of watchmaking at Parkinson & Frodsham's. His connection with the firm will be discussed in a later chapter. He was granted the Freedom of the Clockmakers' Company on October 11th, 1847,

at the same time as his brother, George, when each was " admitted a Free Clockmaker by Patrimony ".

He was in business at Parkinson & Frodsham's at the time of his father's death in 1850, and continued to work there until about 1860, when he went to live at Mount Pleasant, Uplyme, near Lyme Regis, moving later to Elton House, Uplyme. In about 1861 he married, and his wife, Jane, gave birth to two children. See **Appendix III**, page 234.

William Frodsham died on the 21st May, 1901. His effects were valued for probate purposes at £15,318, but in November, 1913, the value was resworn at £16,943.

It will have been noticed that William James Frodsham had two children named " William ". The elder of the two was William Edward Frodsham who was drowned at the age of 20, in 1825, and yet the younger William was born in 1819, six years before the first William's death. This all seems very odd unless the second one was christened after 1825, being given the name " William " in memory of the very talented one who was drowned. The record of the second William's baptism has not been found so far.

Thomas Frodsham

He was William James Frodsham's youngest child. Thomas married Mary Wilkinson on the 22nd April, 1843, and emigrated to Australia. He died on the 3rd March, 1883, and was buried in Hobart, Tasmania. They had six children. See **Appendix III**, page 235.

William James Frodsham, besides being a great chronometer maker and, as we have seen, becoming a comparatively wealthy man, was blessed with a great number of grandchildren, of whom more will be said in the chapters which follow.

CHAPTER VI

THE LIVERPOOL FRODSHAMS

Parkinson & Frodsham employed agents to sell their chronometers, and, in 1821, they had already established an agency in Liverpool, at the premises of Mr. Thomas Jones, an optician.

54 Castle Street, Liverpool

In 1828, **Parkinson & Frodsham** opened a branch business at 54 Castle Street. So far only a few watches of this early period have come to light. They are :—

William Frodsham, Liverpool. No. 1784. This is in a gilt metal case and has a verge escapement. The movement is Continental in style.

Parkinson & Frodsham, Castle Street, Liverpool. No. 1875. It is in a gold case bearing the Chester Hall-mark for 1829. It has a lever escapement.

Parkinson & Frodsham, Castle Street, Liverpool. No. 2014. This watch has a silver case with the Chester Hall-mark for 1829. Lever escapement.

The William Frodsham watch No. 1784 would therefore fit into the series, but why was it signed *William Frodsham* and not *Parkinson & Frodsham* ? Did a William Frodsham have a business in Liverpool prior to the arrival of Parkinson & Frodsham in Liverpool ? Could it have been William Frodsham, The Elder or The Younger ? It is unlikely to have been William James Frodsham himself, since the number is too high for a watch made by him in, say, 1800, i.e., just prior to the founding of the firm of Parkinson & Frodsham.

38 Castle Street

In 1831, Parkinson & Frodsham moved from No. 54 to No. 38 Castle Street, and it would seem likely that Henry Frodsham was employed in the new shop and was soon given the responsibility of running the shop on behalf of Parkinson & Frodsham.

Henry Frodsham **Plate 16**, page 356

In 1834 it would appear that Henry had approached his father, William James Frodsham, and had asked him if he could buy the business. Parkinson & Frodsham agreed to sell, and were willing to accept a bond from Henry. On the 4th October, 1834, Henry "was held and firmly bound" to William Parkinson and William James Frodsham "in the sum of £5000, to be paid to them as follows, £3348.6.8., with interest on the sum of £1498.6.8 part thereof after the rate of £4 per £100 for a year". The first payment of interest to be made on the 13th September, 1838, and then on the 13th March, and so on, paying £25 twice yearly for seven years. Repayment of the capital being at the rate of £283.6.8. per annum, i.e., £75 each March, and £208.6.8. each September. The final payment being due to be made in September, 1844. However, when his father, William James, made his Will in August, 1848, it would seem that Henry was in arrears with his payments, and William James states, in the Will, that he forgives his son, Henry, any debts still outstanding at the time of probate of the Will.

The above loan enabled Henry to commence business on his own account, his firm becoming known as **"Henry Frodsham, chronometer maker, 38 Castle Street, Liverpool".** In 1835 these premises were valued for insurance purposes at £2,990, a cellar having been converted into a workshop.

In the meantime he had married Elizabeth Gully on the 31st January, 1833, but unfortunately she died in August, 1838.

40 Castle Street

In 1838 he moved to 40 Castle Street, and on the 9th April, 1839, when he was 37, he married Frances Louisa Lathbury at St. Michael's Hamlet, Liverpool. They had four children. See **Appendix III.** He had two sons, one of whom, Henry Herbert, was to follow in his father's footsteps and become a clockmaker.

17 South Castle Street

By 1845 Henry had given up the shop at 40 Castle Street and had moved to 17 South Castle Street. A small notebook, dated 1849, gives us the : *"Names and Address of Workmen for Watches",* as follows :—

C. Jones,	Gold Case Maker,	Highfield Street.
Robt. Grace,	Watch Jeweller,	15 Dalton St., West Derby St.
S. Nelson,	Motioner,	25 Standish St., Grt Cross Hale St.
Mr. Barr,	Gold Dial Maker,	Newcastle Place, Clerkenwell.
Robt. Nelson,	Finisher,	211 Great Homer St., Nr Bean St., Kirkdale.
T. W. Willin,	Silver Case Maker,	4 Upper Newington.
C. Clare,	Watch Dial Maker,	St. George's Buildings, 10 Basnett St. 14/- per dozen for Hard Secs.
Powell,	Engine Turner,	22 Basnett St.
Z. Bovey & Co.,	Gold Dial Finisher,	5 Corporation Row, Clerkenwell, London.
Nicole & Capt,	Watch Makers,	80A Dean Street, Soho, London.
P. Clerc,	Gold Dial Maker & Gold Watch Case Maker,	Newcastle Place (4), Clerkenwell, London.
A. General,	Chron^{r} & Watch Pendulum Spring Wire Maker,	5 Gordon St. Vincent Terrace, Islington, London.
Mr. Willcocks,	Watch Dial Maker,	37 St. Ann's St.
Mr. John Dudley,	Jeweller,	8 Radcliffe Terrace, Goswell Rd, London.
Mr. G. S. Griffin,		8 Radcliffe Terrace, Goswell Rd, London.
Henry Shorter,		27 New Charles St. City Road, London.
Mr. —	Gold Case Maker,	17 Green Terrace, Middle St. Clerkenwell.
Mr. Harris,	Baungust's Lever Escpt Maker,	7 Skinner St. Clerkenwell, London
Mr. George Brown,	Gold Balance Maker,	Houghton Street, Prescot.
Mr. Webb,	Gold Case Maker,	53 Spencer St., Northampton Sq., London.
L. Lang,	Engine-Turner & Engraver,	14 Northampton Sq., Clerkenwell, London.
John Dudley,	Jeweller,	14 Sheberton St., Islington, London.
Mr. Tribe,		1 St. George's Terrace, Hyde Park North, London.
Thos. Earnshaw,		48 St. John's Street Road, Clerkenwell, London.

One wonders whether Thos. Earnshaw was supplying complete chronometers for Henry to put his own name on the dial, and one also wonders what " Baungust's Lever Escapement " implies ?

It is interesting to find that as late as 1853 watches were engraved *Frodsham, late Parkinson & Frodsham, Liverpool.* For example, No. 3093, a ¾-plate movement with the Arnold & Dent style of club-tooth lever escapement. This watch has a gold hunting case bearing the Chester hall-mark for 1853.

Henry's father, William James, had died in June, 1850, leaving him £1,000, plus £1,500 which was to be held in trust by the executors of the Will.

Frodsham & Keen

On the 15th October, 1856, Henry joined a nautical instrument maker by the name of Robert John Keen, of 18 Salthouse Dock, Liverpool, in a ten-year partnership, and the business at **17 South Castle Street** became "**Frodsham & Keen**", whilst the **Salthouse Dock** premises became, "**Keen & Frodsham**". The partnership agreement mentions that Henry was not in very good health.

By 1857, "**Keen & Frodsham, Chronometer Makers and Opticians**" were at **11 New Wapping**, and Robert John Keen's address was entered as "**Optician and Chronometer Maker (Keen & Frodsham and Frodsham & Keen), 6 Wesley Street**".

In addition to clocks, watches and chronometers, the partnership now sold simple jewellery, such as rings, ear-rings and lockets, together with barometers, aneroids, night glasses, telescopes, speaking trumpets, sextants, quadrants, log glasses, hygrometers, hydrometers, salinometers, microscopes, drawing instruments, binnacles, compasses, charts, log books, etc., etc.

Frodsham & Keen Marine Chronometers

A number of these instruments survive. The earlier ones may have been sold to the firm by Parkinson & Frodsham, but it is most interesting to discover that a great number of the later ones were made by the firm of Thomas Mercer as pointed out in Tony Mercer's fascinating book *Mercer Chronometers*. The list of Mercer chronometers is as follows :—

Nos.	3838 - 3847	1899	
	3851 - 3852	1900	
	3855 - 3859	1900	
Two-day Chronometers			
	3871	1907	£18
	3875 - 3879	1909	18
	3880 - 3882	1910	18
	3883	1911	18
	3884 / 8138	1911	23.10.
	3886 - 3888	1911	18
Nos.	3889 - 3892	1912	18
	3893	1912	23
	3894	1912	18
	3897 - 3899	1912	18
	3900 - 3902	1912	18.10.
	3903 - 3904	1913	18.10.
	3906 - 3921	1913	18.10.
	3922 - 3938	1914	18.10.
	3939 - 3945	1915	18.10.
	3946	1916	18.10.
	3947 - 3949	1916	18.16.

Nos.	3950 - 3951	1916	19. 6.	Nos.	4043 - 4044	1922	35.
	3952 - 3953	1917	19. 6.		4045	1922	30.
	3954 - 3962	1917	£20.		4046 - 4057	1923	30.
	3963 - 3971	1918	20.		4058 - 4059	1924	26.
	3972 - 3977	1919	23.		4060 - 4061	1924	25.
	3978 - 3989	1919	28.		4062 - 4064	1924	25. 7.
	3992 - 3995	1920	31.		4065 - 4066	1925	25. 7.
	3996 - 4001	1920	33.		4067 - 4069	1925	25. 7. 6.
	4002 - 4010	1920	35.		4070 - 4074	1926	25. 7. 6.
	4011 - 4015	1921	40.		4075 - 4077	1926	25.10.
	4016 - 4039	1921	35.		4078 - 4080	1928	27.17. 6.
	4040 - 4041	1922	35.		13270	1928	38.10.
	4042	1922	30.				

The above numbers are the numbers given to the Frodsham & Keen chronometers.

Death of Henry Frodsham

Henry's health deteriorated rapidly and sixteen months later, on the 19th February, 1858, he died at **101 Parliament Street**. His wife, Frances Louisa, now entered into an agreement with Robert John Keen by which the partnership was to continue until the full term of ten years had been completed in 1866. From the account books it would appear that, following Henry's death, the business was only conducted at South Castle Street. At the termination of the partnership the records of the stock-taking, dated 21st April, 1866, show that the following chronometers were still in stock :—

Nos. 454 and 1681, both second-hand.

No. 2796, an 8-day chronometer.

Nos. 3029, 3058, 3065, 3111, 3117, 3120, 3127, 3136 and 3137, all of which were 2-day chronometers.

The 8-day was valued at £35 and the 2-day at £25 each. One assumes that these were all in the name of " Frodsham & Keen ".

At that time the average yearly takings of the partnership were £5,000.

It seems probable that Frances Louisa Frodsham now sold her share in the partnership to Robert John Keen who then continued to run the business at :—

17 South Castle Street until 1878, it then moved to . . .
9 St. George's Crescent until 1893. Finally the business was transferred in 1894 to . . .
31 South Castle Street until it closed in 1935.

The name "**Frodsham & Keen**" being maintained all this time.

Watches

One interesting Frodsham & Keen pocket watch has survived. It has a reversed fusee and is similar to the calibre used, as we shall see, by Charles Frodsham from 1850 onwards. This watch has a double roller lever escapement but it is not free sprung. Its number is 71/9019. I suggest that the 9019 is the Charles Frodsham number.

Henry Herbert Frodsham **Plate 20**, page 360

As already mentioned, Henry Herbert Frodsham was the son of Henry Frodsham, and the only one of the four children to take up clockmaking as a career.

He was born on the 17th March, 1850, at Abercrombie Terrace, Liverpool. At the age of 14, on the 11th April, 1864, he was apprenticed for seven years to **Thomas Robert Russell**, the well-known watch manufacturer of Liverpool. Frances Louisa agreed to provide food and lodging for Henry Herbert, and Thomas Robert Russell agreed to pay him £10 per annum for the first five years and then £25 per annum for the sixth and seventh years. He completed his apprenticeship on the 11th April, 1871, and his mother, Frances Louisa, died two months later, on the 18th June, 1871, at the age of 57. Her portrait is shown in **Plate 17**, page 357.

As pointed out on page 1, Frances Louisa was the first of the Frodshams to become interested in the history of the family, and it was her son, Henry Herbert, who took the trouble to collect the notes his mother had made and copy them all into a book which became known to the family as "Herbert Frodsham's book".

Thomas Robert Russell appears to have had branch businesses in various parts of the world, and Henry Herbert Frodsham was sent as manager, first to Santiago, then to Valparaiso, and later to Heidelberg and finally to manage their branch in Piccadilly, London.

33 Piccadilly

As shown in the Post Office Street Directories, Henry Herbert Frodsham had his own business premises at 33 Piccadilly, London, from 1881 to 1884.

There are two watches signed " Henry Frodsham " of London, as follows: " Henry Frodsham, Farrington Rd. London. E.C. No. 20377. " This is in a silver case with hall-mark for Chester, 1879, and case maker, T.W. (could this be the T. W. Willin mentioned in the names of workmen ?). The watch has a centre seconds hand with outside circle of 300 divisions, the dial being marked " Improved Chronograph 2/0377. Flat balance spring with index, ¾-plate movement. There is no mention of a Frodsham in Farringdon Road in 1878 in the Post Office Directories. Perhaps Henry lived there prior to moving to Piccadilly ? (" Farrington " Road is not recorded.) "Henry Frodsham, London. No. 46267", is the signature on the back plate of a large full plate deck watch mounted in a brass bowl. The dial is inscribed " Henry Frodsham élève of Parkinson & Frodsham, Change Alley, London ".

Bedford

In 1886, Henry Herbert Frodsham moved to Bedford and set himself up in business as a watchmaker at **7 St. Mary's Street**. In order to help him, Parkinson & Frodsham sent him a number of inexpensive watches and a Poole marine chronometer, No. 3974, with the understanding that he could sell or return them; but most were returned, although the Poole, costing him £12, was retained.

At about this time he married, but, unfortunately, his wife, Lydia, died in childbirth, the child being stillborn. On the 19th February, 1894, he married Catherine Howe at St. Neots Parish Church, Huntingdonshire, and moved to :—

3 Harpur Street, Bedford

By his second marriage his only child, Dorothy, was born on the 20th March, 1897. Three weeks after her birth her father, Henry, Herbert, sustained an accident. Whilst riding a tandem bicycle with a friend, the front wheel hit the curb of the pavement, with the result that Henry fractured his skull, leaving him partially paralysed. Nevertheless, he continued to repairs clocks and watches to the

best of his ability but it soon became apparent that he was, unfortunately, unfit to manage the business. By good fortune his wife, Catherine, had studied optics, and so she set herself up as an optician and the business became known as H. & C. Frodsham, and the watch repairing became a sideline, being dropped altogether when Henry Herbert Frodsham died on the 2nd March, 1915.

Their daughter, Dorothy, became a qualified optician, being the youngest candidate to pass, with honours, the examination for Fellowship of the Association of Dispensing Opticians in 1926. She continued to work at 3 Harpur Street as an optician from 1913 until she retired in 1961 when she made over the business to D. W. Goater who had been her assistant for the previous ten years. . The business is, however, still known as " H. and C. Frodsham ".

CHAPTER VII

PARKINSON & FRODSHAM

Part 2

There are good reasons for believing that when William James Frodsham died he was no longer in charge of the business. Let us consider the facts.

It should be observed that when William James Frodsham made his Will in August, 1848, he did not mention the business of Parkinson & Frodsham at all, in fact the Will commences with the statement " William James Frodsham late of Change Alley, now of Stoke Newington, Middlesex ". This suggests that at some date after William Parkinson's death in about 1842, William James must have handed over the business to George and his younger brother, William. William James died at the age of 71 in 1850. Would it be fair to assume that he probably began to retire from business when he was 65, i.e., in 1844 ? I suggest that he actually handed over the business to George and William in 1847, a year before he made his Will. My reason for this is that on the 11th October, 1847, George and his brother, William, both of Change Alley, were each " admitted a Free Clockmaker by Patrimony ". These last two words give us the clue and suggest that they had been made Free on account of having been given the business by their father.

(A Freeman is entitled to pass on the Freedom " by Patrimony " to his son providing that the son was born after the date of admission of his father to the Freedom.)

George and William remained in partnership at **4 Change Alley** until about 1860 when William moved to Uplyme. George probably bought William's share, so that William, who was now 41, could afford to retire; he had already received £3,000 as a legacy from his father. There is no evidence to show that he continued to work as a watchmaker in Devon.

George Frodsham was therefore in charge of the business from 1860 until his death in July, 1873, at Moorcroft House, Hillingdon, near Uxbridge. His effects were valued at £8,000. In his Will, which he had made in January, 1852, he mentions " the business of a

Chronometer Maker carried on by me in Partnership with my brother William Frodsham ". This proves that George and William were in partnership in 1852. George's wife, Mary Ann Frodsham, was the Honorary Legatee for life mentioned in the Will.

George William, the only son of George Frodsham, now took charge of the firm in 1873. It was still at 4 Change Alley.

George William Frodsham

The only son of George Frodsham. He was born on the 16th May, 1847, so that when his father made his Will in January, 1852, George William was only four, which was why Mary Ann was made the Honorary Legatee for life. Although George lived for another 21 years, he had failed to make a new Will during that time.

George William Frodsham was married to **Mary Maria Gardner** on the 18th April, 1872, in St. Alphege Church, Canterbury. They had six children. See **Appendix III**, page 233.

The Frodsham Black Book

Mary Maria Frodsham was the author of the book already mentioned on page 1. She lent this valuable document to some of her relatives who were sufficiently interested to make copies of it. She also sent a copy to a Frodsham not directly related to the clockmaking family, this was George Horsefall Frodsham who became Bishop of North Queensland. This is the 73-page typewritten copy which Mary had employed a typist to make for her so that she could send it to the Bishop. Mary wrote a long letter which was posted on the 8th of January, 1905, together with the typewritten copy. At the end of the letter she said :—

> I hope you will think the Type writing is well done and will not think the charge of one guinea too much. I am afraid it is more than you expected, only no doubt it is a longer M.S. than you thought it would be.

This helped the Bishop to trace his family back to John Frodsham in 1620. However, in her next letter to the Bishop dated June 29th, 1905, Mary wrote :—

Thank you also for so kindly sending me 30/- for the expences. I had actually paid 25/- for the Type-writing, but I had not considered it honest to ask you that, as I knew there were repetitions made & also much type written which could hardly have been of interest to you. Now you kindly send this I am quite fully paid as the parcel was only 2/-.

Mary continued to add to her notes until her death on the 18th July, 1917. The other two copies were handwritten, one was made by Hilda Frodsham in June, 1916; she was the wife of Harold Leslie Frodsham (the grandson of Henry Frodsham). The other copy may well have been made from the Hilda Frodsham copy, possibly by Blanche Frodsham (the mother of Arthur Mannington Frodsham who now owns this copy). Mrs. Ann Frodsham (the wife of Arthur Mannington) very kindly made a copy for me in longhand.

Vulliamy

It is interesting to find that the Frodshams are related to the Vulliamys. Mary Maria Frodsham's brother was Austen Walter Gardner, and his daughter, Constance Marion Gardner, married Hugh Francis Vulliamy. Hugh Francis Vulliamy was a direct descendent of Benjamin Lewis Vulliamy. See **Appendix VI**.

Electricity and Magnetism

In February, 1871, George William Frodsham gave a lecture to the Horological Institute on " Electricity and Magnetism ". The two chief points in the lecture are as follows :—

1. Variation in the intensity of the earth's magnetism has an effect upon the going of clocks with iron or steel pendulum rods by creating a corresponding increase in the magnetism, and consequently attraction of the steel or iron rod of the pendulum, and an increase in magnetism will cause an acceleration in the vibrations of the pendulum; and a decrease in magnetism will, of course, have the opposite effect.

With iron rods the errors will be proportional to the squares of the variation in the earth's magnetic force, whilst with steel rods the errors will be simply directly proportional to these variations. Hence

steel will be preferable to iron, whilst wooden rods will not be affected at all.

2. Since the centre of gravity is not in a fixed position with regards to the earth's surface, this may also be a source of error.

Paris Exhibition, 1867

Parkinson & Frodsham exhibited the following watches :—

Lever escapement — Nos. 4091, 4725, 4966, 4997, 5004, 5011, 5032, 5062, 5100, 5102, 5139, 5175, 5176, 5235, 5244, 5268, 5295, 5298, 5323 and 5326.
Chronometer — Nos. 4711, 4729, 5021 and 5076.
Duplex — Nos. 2517 and 5288.

and also :—

Marine chronometers — Nos. 3876 and 3908 (both of 2-day duration).

Le Havre Exhibition, 1868

The following watches were shown :—

Nos. 3852, 4729, 5004, 5214, 5235, 5298, 5312, 5368, 5381 and 5403. The only chronometer being No. 4729.

Six marine chronometers were exhibited :—

Nos. 3876, 3905, 3909, 3923, 3934 and 3949. All 2-day except No. 3905, an 8-day.

Calcutta Exhibition, 1883

A large pocket chronometer No. 1153 was shown with watches Nos. 2517, 3727, both duplex, and Nos. 5066, 5585, 6045, 6500 and 62692, all levers.

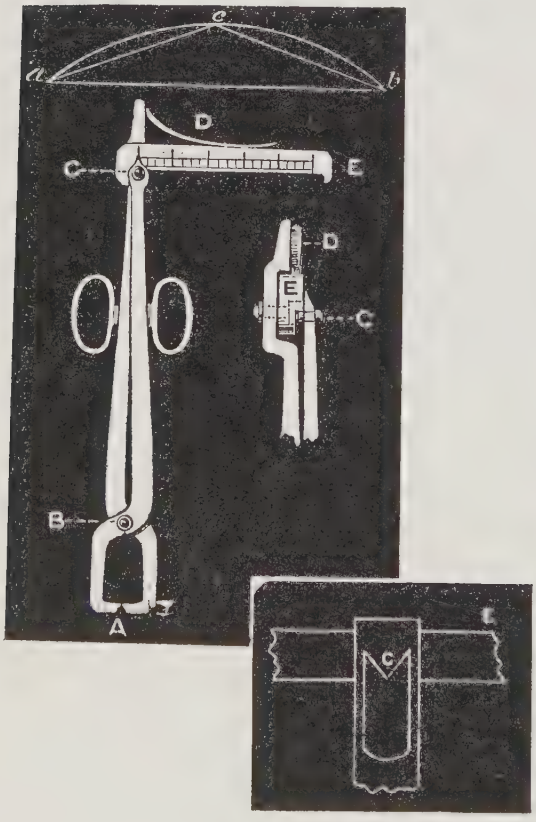
Carriage clocks, Nos. 114, 566, 2919 and 3061, and a chiming clock, No. 1366.

Paris Exhibition, 1889

Watches Nos. 3445, 3852, 4446, 5288, 5609, 5679, 5813 and 6121, of which No. 5288 was a duplex and No. 5679 a pocket chronometer.

" Outil aux Douzièmes "

In November, 1871, George William Frodsham wrote a short article under the above title for the *Horological Journal.* In this he pointed out that the tool is faulty because, measurements upon an arc of a circle are compared with chords of arcs of a smaller circle, the diameters of the two circles having a fixed ratio between them. To cure this he suggested pivoting the arm E as shown in the diagram. However, another error was pointed out by a Mr. Virgo, to the effect that the scale on E should have the pointer C pointing at the edge of the scale (as in the small diagram). " The scale is also wrongly divided, it should be divided first into halves, then into quarters, which latter may be sub-divided to any reasonable extent. Then the total length being 5 inches, but only being supposed to represent an inch, half of it, or $2\frac{1}{2}$ inches would accurately represent half an inch of thickness or length of any hard substance enclosed within the lower jaws."



The above tool is better known as a " Douzième Gauge ".

Special Loan Exhibition, South Kensington, 1876

Parkinson & Frodsham exhibited three marine chronometers and in the " Chemistry " section showed a **Doberawer's or Philosopher's Lamp**, which was described as follows :—

> This lamp when charged with dilute sulphuric acid is self-igniting; it suffices to raise the arms of a small figure, and the spongy platinum then brought into view becomes incandescent. The explanation of this is that the hydrogen generated in the body of the lamp, which contains zinc, is drawn into such close contact with the oxygen of the air, by reason of the extreme fineness of the spaces between the particles of the platinum, that the two gases combine chemically, or in other words burn, whereby sufficient heat is generated to raise the temperature of the platinum to a red heat, sufficient to ignite paper, etc.

One wonders what this has to do with clockmaking !

The Breaking of Main-Springs

In October, 1877, George William was sufficiently interested to write a letter to the *Horological Journal*, to the effect that in his opinion electricity had nothing to do with the breaking of main-springs as suggested by H. Reinecke in his article in the September, 1877, issue of the *Journal.*

Livingstone Search Expedition

On February 8th, 1872, Parkinson & Frodsham lent two silver pocket chronometers to Lt. Dawson, who was in command of the Royal Geographical Society's expedition which was being organised to search for Livingstone. These watches are recorded as being No. 5674, a whole plate movement, and a ¾-plate keyless chronometer, No. 4711. They were returned to the firm on September 13th, 1872.

Mrs. Belville

In 1882, on the 20th July, a silver pocket chronometer, Parkinson & Frodsham No. 5076, was given to Mrs. Belville. Perhaps it was

" presented to her " since there is no record of any charge for it ? Almost certainly this was the Mrs. Maria Elizabeth Belville (née Last) who sold " Greenwich Time " to chronometer makers. (See *John Arnold & Son*, page 83.) Her daughter, Elizabeth Ruth Naomi, had been born on the 5th March, 1854, when they were living at 9 Hyde Vale Cottages, Greenwich. Unfortunately, Mrs. Belville's husband, John Henry Belville, died in 1856, so that she was left with the problem of bringing up a two-year-old child. She decided that the only thing to do was to continue to give the service which her husband had undertaken, i.e., the selling of Greenwich Time. This she continued to do until she retired in 1892, when her daughter carried on the work. (See Supplement to *John Arnold & Son* and *Greenwich Time* by Derek Howse, pages 84 - 86.)

Miss Belville

Incidentally, Frank Thirkell can well remember meeting the famous Miss Elizabeth Belville on numerous occasions. He first saw her when she visited the Regent Street branch of Mappin & Webb (where he was employed) to make one of her usual calls to sell them Greenwich Time. This would have been in about 1936. Her routine was to go to Greenwich in the morning to check her pocket chronometer and to obtain a certificate regarding its rate from the authorities at the Observatory. Then, armed with this certificate, she would proceed to visit various shops and factories, such as the Mazawattee Tea Company, where, for a small fee, she would sell them the correct time. In 1939, when Mr. Thirkell moved to the main branch of Mappin & Webb in Oxford Street, Miss Belville used to call there, in spite of her being 85 years of age, and he recalls her saying to him on one such occasion, " I've brought Charles today since Arnold is not very well ". " Charles " being her large deck watch made by Charles Frodsham, No. 07586, which she had purchased from the Admiralty in June, 1926. See Chronometer Records.

On another occasion, when discussing the use of the telephone in order to obtain the exact time, she said to him, " TIM, what a vulgar name, don't you think ? ". TIM, of course, spelt the end of the need for her service, but she was such a delightful character that some firms continued to welcome her for a while.

When she made her Will in 1921 she was living at Ewell Cottage, Surrey. In her Will she said " I should wish the Royal Observatory to have first offer of purchasing my chronometer Arnold 485 ". There is unfortunately no mention of any other chronometer.

Chronometers

The firm continued to sell marine chronometers and the following were made for them by the firm of Thomas Mercer :—

Nos.	3305		1879	£16
	3500		1879	
	2523	Incomplete	1881	£15.10
	3536	,,	1881	£15.10

These numbers are difficult to explain. The Greenwich records show that No. 4099 was purchased by the Admiralty in 1875, so that it seems to be unlikely that No. 3305 was completed four years later. It is, of course, just possible that No. 4099 was a pocket chronometer. One wonders whether, in fact, the above four numbers were Mercer's own numbers ?

A number of pocket chronometers of excellent quality were also made, for example No. 4608 which is shown in **Plate 13**, page 354.

The business flourished at 4 Change Alley until 1890, and then, owing to the rebuilding of Change Alley, they had to move and it was 16 years before they really settled down again. Their addresses (none of them far from Change Alley) were as follows :—

From 1891 to 1892	**16 Queen Victoria Street.**
1893 to 1895	**35 Royal Exchange.**
1896 to 1905	**15B Royal Exchange.**
1906 to 1947	**5 Budge Row** (between Cannon Street and Queen Victoria St.).

Nevertheless, in spite of all these upheavals, the firm had continued to prosper and to sell watches of fine quality such as No. 7269, a minute repeating clock watch which has the address 15B Royal Exchange. **Plate 15,** page 355.

Night Watchman's Clock

Fine clocks of all types were produced by the firm including Night Watchman's clocks. An excellent example of such a clock is shown in **Plates 8 and 9**, pages 351 - 352. It is particularly interesting in having a bell which acts as a passing quarter strike thereby reminding the watchman that it is time to depress the plunger. (Possibly Filiary's patent.) The clock has the letters C.E.P. stamped on the front of the dial plate, and the number 1317 stamped on the back plate.

Secret Code of Costs of Manufacture

A few of the old Parkinson & Frodsham ledgers and workbooks survive. Most business firms had their own secret code of 10 letters to represent the numbers 1 - 9 and 0. In this case the code words were lost in the past. However, after much thought, the following formula was found by a process of elimination :—

J O H N D U C K E R
1 2 3 4 5 6 7 8 9 0

Other firms' codes are known, but since they are still in use, they cannot be revealed.

George William Frodsham's death

He died on the 29th March, 1912, leaving the business to his wife, Mary Maria, and on the 1st August, 1912, she sold the goodwill of the business and the right to use the name " Parkinson & Frodsham " to her husband's foreman, **William Charles Shrubsall Harris**, of 81 Nelson Road, Hornsey, for the sum of £50.

When probate was granted for George William Frodsham's Will, his estate was valued at £1,623.

William Charles Shrubsall Harris

Born on 17th March, 1867, the son of Edward Edgar Harris, of 41 Railway Street, New Brompton, near Chatham, and apprenticed at the age of 15 to Henry Frank Reimers, of 34 Percy Street, Tottenham Court Road, to learn the art of watch and clock making, for a

period of five years, commencing on the 17th July, 1882. Edward Edgar Harris agreed to pay Henry Reimers, by way of premium :—

£50 at the commencement of the first year,
£25 ,, second ,,
£25 ,, third ,,

Henry Frank Reimers agreed to pay William Charles Shrubsall Harris :—

2/6 per week by way of pocket money for the first three years
3/6 ,, ,, fourth year
4/6 ,, ,, fifth year,

and to provide sufficient meat, drink and lodging during these five years.

At the end of his apprenticeship William Charles was given a certificate to prove that he had faithfully served his time, and to recommend him as an industrious, good and honest workman. That was on the 19th July, 1887.

Probably, fairly soon after this, he was employed by George William Frodsham, gradually working his way up to become a foreman. He is believed to have been a highly skilled craftsman and to have had great ability, so that the running of the business of Parkinson & Frodsham presented no great problem for him when he acquired the business in 1912.

The 1914 - 18 World War created a great demand for accurate chronometers and this must have been a boon to such firms as Parkinson & Frodsham.

In 1919 William Harris was granted the Freedom of the City of London.

He died on the 26th April, 1955, but his son, Geoffrey Charles Harris, had taken charge of the business on the 6th June, 1925, when he was 21, although his father, William, was only 58 at the time.

Watch in a Ring

William Charles Shrubsall Harris became " Watchmaker to

H.R.H. Princess Fred[a] Will[m] of Prussia " as shown on the Parkinson & Frodsham notepaper of his time, and the story goes that in about the 1890's he made an extremely small watch placed in a ring for the Princess. The ring was much admired by one of the Princess's friends who then applied to William Harris asking to have one made on similar lines. William, of course, had to ask for the permission of the Princess to do so, but it was not granted.

The notepaper also tells us that the firm were " Watchmakers to the Admiralty and Counsel of India. Makers of Standard Clock for Washington Naval Observatory, U.S.A. Makers of Standard Chronometer for the Port of Malta."

Geoffrey Charles Harris

He was born on the 22nd August, 1903, at Nelson Road, Edmonton. He trained as a watchmaker and became foreman at Bensons. He was a most versatile man with unbounded energy, a keen racing cyclist, winning numerous medals. Another of his interests was motor-car racing, his speciality being Morgan cars and, being a first-class mechanic, he, of course, did all his own repairs. He was also a very fine watchmaker, quite happy to undertake the most difficult repairs himself. He was a born magpie, and could never bring himself to throw anything away; as a result his house was littered with parts of cars, bicycles, clocks, watches, marine chronometers, etc., etc., etc.

Nevertheless, he continued to run Parkinson & Frodsham's shop at 5 Budge Row most successfully until the 19th July, 1944, when the premises were bombed for the third time. This time the damage was beyond repair, so that he was forced to leave having, of course, lost most of his clientele. However, he continued to work for a time from his home at 6 Redstone Road, Hornsey, but the address of the firm was still 5 Budge Row. He received approximately £135 for war damage. **Plate 21**, page 361.

The firm of Parkinson & Frodsham ceased to exist in 1947.

Geoffrey Harris now became a locksmith. He designed a time-lock which was made by Smith's, and he worked for the firm from 1949 to 1960. Smith's moved from Cricklewood to Northampton where they continued to make locks.

He then worked for the Chubb & Sons Lock & Safe Co. Ltd., making time-locks and continuing to do this until his death on the 9th February, 1979.

Mr. M. B. Herbert, late of Hornsey, used to work for Geoffrey Harris, he is now believed to be living in Kent.

Greenwich Time

It is said that a Miss Frodsham, who died in 1954, and who used to stay at 87 London Road, Ewell, was one of George William Frodsham's daughters. This Miss Frodsham is believed to have sold " Greenwich Time " to chronometer makers, in the same way that the famous Miss Belville used to perform this service. It has not been possible to verify this statement which is believed to have been made by the late Geoffrey Harris. In view of the fact that Miss Belville used to live at Ewell, it may well be that Geoffrey Harris was misinformed.

CHAPTER VIII

CHARLES FRODSHAM

Charles Frodsham was the third son of William James Frodsham. He was born on the 15th April, 1810, and baptised at St. Pancras on the 8th January, 1812. He was educated at Christ's Hospital (the Blue Coat School), having been presented by one of the governors, Sir Charles Flower, an Alderman of the City. He entered the Foundation in April, 1818, and remained there until June, 1824. Apparently one of the conditions of entrance was that, at the age of 14, when the children were expected to leave school, they should be apprenticed to a Master. Charles was no exception. He received his grant of £5 and was apprenticed to his father, William James, on the 14th July, 1824, for seven years.

Greenwich Trials

Whilst still an apprentice Charles submitted his first marine chronometers for the Premium Trial commencing October, 1830. They were numbered 1 and 2. **The second Premium prize** of £170 was awarded to No. 2 at the termination of this, the ninth trial, in 1831. During the whole of the 12 months of daily observation of No. 2, its greatest daily variation was only 86/100th seconds. Cotterell No. 311 had won the first Premium prize and its greatest daily variation was 70/100th seconds.

In November,	1831,	Charles	submitted	Nos. 3 and 4.
December,	1832,	,,	,,	Nos. 4 and 8.
January,	1834,	,,	,,	Nos. 18 and 19.
March,	1835,	,,	,,	Nos. 1504, 1521, 1523 and 1529.

From 1831 to 1834 he gave his address as Change Alley, but in March, 1835, it was " Islington ".

This was the last of these Premium Trials. No. 1529 was withdrawn just before the commencement of the trial. Of all these chronometers, No. 2 was the only one to win an award — a splendid achievement indeed for an apprentice who was only 20 years old at the time.

In 1833, at the age of 23, he was made a Fellow of the Royal Astronomical Society. This was a rare distinction for one so young.

Charles seems to have commenced business on his own account in 1834, at about the time of his marriage to Elizabeth Mill on the 28th April, 1834. Why did Charles decide to set up on his own ? It is difficult to understand. His eldest brother, Henry, was already established at Liverpool in 1832; his only other elder brother, William Edward, had been drowned in 1825, so that, being the third son, one might have expected that he would have joined Parkinson & Frodsham. It was left, however, for his two younger brothers to join that firm in later years.

Soon after his marriage Charles was living at **Barossa Place, Islington.** The rate books show that a " Fordsham " was living there in 1835, but there is no mention of the name in either 1834 or 1836, so that he probably moved there in 1834. This was also his business premises because, when he entered the four chronometers for the 1835 trials, he gave " Islington " as his address.

In 1836 he moved to **5 Navarino Terrace, Hackney**, living there until 1843.

It can therefore be said that the famous firm of " Charles Frodsham " was founded in 1834. In 1837 he decided to commence business in the City of London, and rented premises at **No. 12 The Pavement, Finsbury**, moving one year later to larger premises at **No. 7 The Pavement**, London Wall.

His next move was to advertise in the *Nautical Magazine* in April, 1840. This can be seen in **Plates 22 and 22a**, pages 362 - 363.

His business prospered, and he was selling chronometers to the Admiralty.

Then in 1840 he availed himself of the opportunity to submit his chronometers for the new Airy trials and straightaway his No. 1715 performed extremely well, gaining 21.8 marks. He was now recognised as one of the leading chronometer makers.

Two examples of his early marine chronometers are shown in **Plates 23 and 24**, pages 364 - 365, i.e., Nos. 1614 and 1724.

It is difficult to believe that Charles made over 1,700 marine chronometers prior to 1843. It seems likely that his numbering commenced at 1,000 or possibly 1,400, since the lowest number of this series that has come to light is No. 1447.

J. R. Arnold - Chas. Frodsham, 84 Strand

Soon after John Roger Arnold's death in 1843, Charles Frodsham approached his executor, Richard Steele, and succeeded in buying the business at 84 Strand together with the stock in trade. He soon moved in and the firm became known as Arnold & Frodsham, watches being signed *J. R. Arnold - Chas. Frodsham.* This was a very wise and courageous move; the name of Arnold was still renowned the world over. Although E. J. Dent had set himself up at 82 Strand, next door but one to 84 Strand, the latter had the advantage of being a corner shop leading to Cecil Street.

84 The Strand was at one time " The Cecil Coffee House " which had a corner-stone dated 1696. When the premises were rebuilt in March, 1882, this corner-stone was incorporated in the building, but unfortunately, when the latter was demolished in the so-called " Strand Improvement Scheme ", the corner-stone was lost. **Plate 25**, pages 366 - 367.

The double title was retained by Charles until 1858 when the firm became **" Charles Frodsham, 84 Strand "**. Nevertheless, a few letters were still being addressed to Arnolds, 84 Strand, until as late as 1868.

As previously pointed out on pages 172 and 173 of *Edward John Dent,* although Charles Frodsham had purchased the lease of the premises and the goodwill of the business he was not fortunate enough to be given the job of repairing the Arnold Government chronometers which were at that time undergoing repair at 84 Strand, and so Charles had to hand them over to Dent much to Dent's delight, which he expressed in the letter to Messrs. E. & J. W. Blunt, dated September 19th, 1843 :—

> Charles Frodsham has taken Arnold's business, and has made a sad mistake. The Government have given me the **whole** of the

chronometers, which were made by Arnold, which must be a sad cut up to his purchase.

However, as we shall see, it did not take Charles long to win Airy's confidence in his ability.

Arnold, Frodsham & Co., Liverpool

There are in existence two watch movements signed *Arnold, Frodsham & Co., Royal Exchange, Liverpool*, so that Charles must have had a branch business in Liverpool. It would be interesting to know who was the member of the firm indicated by the word "*Co.*", but so far this remains a mystery. Both the watches are typical Liverpool runners, having lever escapements and the "Liverpool windows" type of jewelling. One is numbered "12011", the other, "21986", widely differing numbers which it is difficult to explain.

G. B. Airy, Astronomer Royal

Very soon after Charles had acquired the J. R. Arnold business, we find Charles writing to Airy. Their correspondence is most interesting and it shows how much they grew to respect one another and to ask one another for advice. These letters commenced in 1843 and continued until Charles' death in 1871.

Quick Trains

On the 9th November, 1843, Charles wrote to Airy :—

I beg to inform you that 3 of these watches have quick trains and will be found exceedingly useful on board Her Majesty's Steamers, Cutters, and fast sailing vessels etc., also for surveying purposes, as they are not so subject to derangement, nor so much under the influence of external motion as the ordinary half second Chronometer.

It is a singular fact that I have lately had occasion to adopt this train, and I have taken some credit to myself for it, and altho' I find it was employed 40 or 50 years ago, I feel assured it was not with the design of accomplishing the same end which I had in view, or its advantages would certainly not have been lost sight of, and the train abandoned.

One of my strongest reasons for departing from the ½ second train was, the difficulty of carrying such a Chronometer, a mile or two to put it on board ship, with any certainty of its preserving the same relation to Greenwich time it had on setting out. The cause of this is that the weight of the balance is too great for the strength of the pendulum spring. This defect is so far remedied in the quick train, that it is really surprising to find with what certainty, a Chronometer may be carried by an ordinary person, without altering its previous relation to time.

I have made several of these Chronometers for small vessels trading to the Mediterranean, and have placed with them for comparison an equally good ½ second Chronometer; and the accumulation of time as per rate was always in favour of the quick train.

The Chronometer deposited by me last season at the Royal Observatory, and was purchased by the Government was upon this construction.

I do not however wish to infer that the quick train is superior to the half second, when used in a fixed observatory or in large vessels.

Louis Berthoud is said to have experimented with very quick trains and Gould mentions one chronometer beating three to the second. Earnshaw No. 549 beats 130 per minute (not to be recommended), and Gould also says that he believed that one of Frodsham's chronometers, beating 160 per minute, was used by Airy in the abortive Dolcoath experiments for determining the earth's density.

It would appear that the advantages of a quick train were outweighed by the disadvantage of the difficulty in reading fractions of a second, other than half seconds, and the use of quick trains for chronometers was not adopted, and was soon abandoned by Frodsham.

The Frodsham - Arnold Balance

In a postscript to the above letter Charles says, " To one of the quick trains I propose to carry out a plan of J. R. Arnold's for

overcoming the error in the middle temperatures by continuous motion". Five days later, on the 14th November, 1843, Charles again wrote to Airy :—

The compound rim balance cannot be too highly prized by the true mechanical, as possessing in an eminent degree both the properties of a fly wheel and those of a compensating regulator; and although a slight error in compensation results from its use, yet this does not arise from any defect in its principles; but from its perfect obedience to its own natural laws by which it tends to the centre with an equable motion as the temperature proceeds from cold to heat.

But as the motion towards the centre is required to be with a certain rate of accelerated motion, it follows that if any arrangement can be devised by which the weight may be so carried to the centre, a perfect balance will be the result; and of such a nature is the balance I propose to employ for correcting the error in extreme temperatures by continuous motion.

The following is a description of the balance and a statement of the mathematical laws which govern its motions.

The diagram will sufficiently explain the general nature of the balance, and it will only be necessary to state that the bars which bear the globular weights, are compounded of brass and steel, the steel being on the inner side.

From the extreme regularity of the compound metallic spiral Thermometer, it may be inferred that equal degrees of heat will carry the weights over equal arcs. Let therefore a succession of equal arcs be taken regularly up the quadrant from the base; and let us further suppose the weights to be carried over the equal intermediate arcs, (Diagram No. 2) as the heat proceeds from extreme cold to middle temperature, and thence to extreme heat. [**Plate 26**, page 368.]

The distance from the centre in each of the three points, is measured by the natural cosine of the angle of elevation; and as each three of these cosines have different relations of distance to the centre, and at each different angle of the quadrant, there is a different rate of acceleration in the motion of the weight

toward the centre, I deduce that a certain angle may be found, in which the precise ratio of acceleration will obtain which the true distances require.

My experiments are as yet too incomplete to decide positively as to the angle required, but I feel assured that the balance will not only be a very effective but a very simple one.

I beg to request that this communication may be considered a private one, although I have no intention of taking out a patent, as I consider them contrary to the best interests of science.

These rather crude diagrams of 1843 remind one very much of the refined version depicted in the *Revue Chronomique* of November, 1876; this was translated by Messrs. Chas. Frodsham & Co., and published in the *Horological Journal* in November, 1877, page 32. On page 40, the firm described the Charles Frodsham versions of the balance; at first he placed a J. R. Arnold balance on top of the bar of an ordinary compensation balance, Figs. 1 - 4, and then, in later years, he evolved a variation of this balance, using a modification of the Hartnup three bar type, as shown in Figs. 5, 6 and 7, whilst the Winnerl type can be seen in Figs. 8 - 11. **Plate 27**, page 369.

There is very good reason to believe that Charles was using the modified John Roger Arnold type as early as 1843; the postscript to the letter of November 4th suggests it. Also the fact that a marine chronometer, signed John R. Arnold, No. 451, has this type of balance, fortunately with the words " Restored by Charles Frodsham, 1845 " engraved upon the movement. This makes one feel fairly sure that the balance was applied at that date. As we shall see, modifications of the Hartnup-Frodsham type were being applied to marine chronometers long after Charles' death. **Plate 27**, page 369.

Rebuilt by Chas. Frodsham

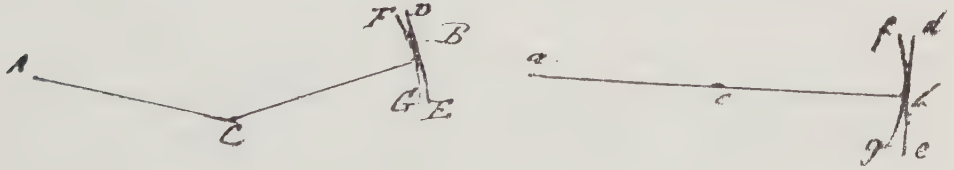
When Charles made any major alteration on an Arnold chronometer he put an inscription to that effect on the chronometer, usually on the balance cock. J. R. Arnold No. 255 is inscribed " Rebuilt by Chas. Frodsham. A.D. 1845 "; the back plate has no slot, and it would seem that a new back plate was given to the

chronometer when it was converted to an Earnshaw escapement. J. R. Arnold, No. 338, is inscribed " Restored by Charles Frodsham, A.D. 1845 ". It now has an Earnshaw escapement and a Hartnup balance. The back plate has the empty slot for the previous Arnold type detent. J. R. Arnold, No. 412, was " Rebuilt by Charles Frodsham in 1850 ". It now has electrical contacts.

Another chronometer whose number is unknown is inscribed " Restored by Chas. Frodsham, A.D. 1847 ". All that remains to prove this is the cock and an Earnshaw type balance with an Airy's bar which must have been added much later than 1847. [See **Addendum** at the end of this chapter, page 149.]

On February 13th, 1845, Charles wrote to Captain Beaufort to ask for permission to send two chronometers (fitted with his new balance) to be put on trial at the Observatory. Captain F. Beaufort, the Hydrographer, passed the letter on to Airy, who wrote to Charles to the effect that Captain Beaufort would probably grant him the necessary order, in which case, he said, " send the chronometers as soon as you please, without waiting for a Monday ". The letter continues :—

> In regard to the advantage of the construction which you propose, I think you will find that you are under a mistake.
>
> Your notion appears to be that, (supposing for more easy comprehension that the thermal bending takes place entirely at the centre), if the original position of the bar at mean temperature be ACB instead of acb as proposed by Mr. Arnold, the throwing inwards of A and B by the thermal bending at C will be larger than the throwing inwards of a and b by the bending at c.



> But in this you have not considered that the correction effect does not depend on absolute and simple throwing in of the A and B, but upon their throwing in with reference to the state as corrected by the simple compensation.

The state as corrected by the simple compensation may be represented by saying that the motion of B is the same as at the neighbourhood of mean temperature; that is, it is in the direction of DBE which is a tangent at B to the curve really described.

The curve really described is FBG.

The corrective effect of the bending in a curve like a circle depends therefore upon the distance of F from D and of G from E.

And these are sensibly the same as the distance of f from d and of g from e.

It is unfortunate that you delayed your application for trial till the cold weather was past. I doubt whether it is worth while now to make the trial.

The Middle Temperature Error

It had been observed by Dent in 1833 that a marine chronometer, with an ordinary compensation balance, tends to lose when exposed to extremes of heat or cold. To cure this it was necessary to increase the rate of the balance at these times. The easiest way to do this is to have an auxiliary weight which moves in towards the centre of the balance. To do this for either extreme heat or for extreme cold was not too difficult, but to make the auxiliary weight move inwards when exposed to both heat and cold was not at all easy.

Now if we look at the Arnold - Frodsham balance as described by Charles in his letter of November 14th, 1843, and examined theoretically by Airy, as above, it will become obvious that this balance can be made to cure one or other evil but not both, since the bar CB moves inwards to F, but outwards to G.

The Theoretical Cure

In theory, if Arnold had applied a weight at the end of a, and one at b, in Airy's diagram then it would appear to have been possible to cure both errors at once since the point b can be seen to move inwards to f in heat, but also inwards to g in cold. Unfortunately John Roger Arnold placed **vertical rods** to carry the weights at a and b, so that the weight would be thrown in as the bar bends upwards, but out as the bar bends downwards, as can be seen in

Fig. 4, **Plate 27**, page 369. He had to do this in order to obtain sufficient movement of the weight in an inwards direction. In the Arnold - Frodsham balance the bar is prevented from bending downwards by the screws. **Plate 27**, page 369.

To return to the Frodsham - Airy correspondence; on February 17th, 1845, Frodsham replied to acknowledge Airy's letter and went on to say :—

> I beg to say that I have made so many experiments and have used different balances of every form and shape each promising great results but without success. That its merits must depend upon authentic evidence of its usefulness, which from experience I find must be the case with all apparent improvements however good in theory; there is however a strong natural law in favour of the present form, which I think will lead to useful results.
>
> I do not take for granted that it entirely moves from the centre, if it did the difference of cosines in some angles would be strongly in its favor, the motion however must take place there notwithstanding the bar tends to form a spiral curve.
>
> Having spent so much time and money in order to improve the compensation balance since the decease of Mr. Arnold I shall be glad to avail myself of your valuable assistance, being aware that Mechanics has had a considerable share of your valuable time and attention — if ultimately I should succeed I shall be gratified by science deriving benefit from my exertions.

Airy's Remontoire

On the 10th March, 1845, Charles wrote to Airy :—

> I have the honour to inform you that I have applied your improved escapement to a small clock and, as far as I am at present able to judge, with particular success, the simplicity of which is truly remarkable — the clock I have applied your improvement is a half dead beat escapement and its vibration is increased which I find to arise from the Remontoire spring giving way to the recoil instead of backing the whole train — on applying considerable power after going an hour the vibrations did

not increase but had the effect rather to impede it. The clock is a skeleton and therefore afforded one the opportunity of observing its motions throughout the day.

I am now about to apply your escapement to a known good Astronomical clock when I will do myself the pleasure of reporting to you the results.

This is most interesting. Was Charles applying the Airy remontoire as seen in Dent's Regulator No. 587, which is now at Greenwich ? It sounds suspiciously like it. Let us hope that a Frodsham skeleton clock or regulator with a remontoire will be found to settle the matter.

Balance Spring. Effect of hardening and tempering

On December 24th, 1846, Charles wrote to Airy :—

I omitted to mention in my report of the chronometer No. 420 [? Arnold] a circumstance which shows how much a chronometer is under the influence of its pendulum spring; the balance with the spring in a soft state vibrated little more than 200°, whereas the identical spring, when hardened and tempered caused the balance to vibrate 400°—the difference in the extent of vibration is not always so great as in this instance, but it is always considerable, yet, as far as I have been able to observe, the progressive loss of elasticity by heat follows a similar ratio. It is singular that the loss of elasticity by heat should have been known to D. Bernoulli and Berthoud (*Traite de Horloges Marine* p. 84, 86.) a century ago, as is evident from their writings, and so accurately that the latter in sending his Chronometer No. 8 to sea, gave a correctional error which points out most clearly that the middle temperature error was known to him and subjected to enquiry (p. 308).

On April 29th, 1859, Charles wrote to Airy to thank him for his letter of the 25th, and said :—

The apparent gaining in heat by the reversed compensation

balance is most remarkable. I should like to know to what extent the errors in temperature is less for 60 degrees.

One of my experiments was to use a reverse compensation balance in company with a compensation balance — that is to say, the Chronometer had two balances in the same verge. I was in hopes of neutralizing the defect, the proportions I used were excellent, but the result gave that everlasting error the minimum of 2.5. The Chronometer's performance is nevertheless most remarkable — at sea and on shore. It is now the property of Lord Robert Cecil. Your letter will necessitate either a fresh experiment or a revision of the above Chronometer, (No. 4006.)

[This chronometer is still in existence, it is dated 1852, and was shown at Asprey's in 1972. **Plate 29**, page 371.]

When I wrote you last I was completely down and was so humiliated at having effected little or nothing notwithstanding the considerable expenditure of money and time. Now I soon returned to the charge and have commenced a thorough new investigation of the motion by calculation of every part of the present balance, which has already lead to some remarkable experiments and the construction of 3 new balances, or rather a different treatment of the present balance, I mean continuous motion — all check pieces I reject. The construction is most simple—if they succeed it will be a wonder it was not done before. You are aware the time it takes to come to final results. Succeed or not I will do myself the honor of communicating the result.

I would have accepted the Hartnup balance had it been perfect, but it is not — and it is equally difficult in construction and in want of simplicity and is also mechanically defective as a good balance or governor. But if as I suspect wherever the compound metal exists, the error of antagonism will be found. If by good proportions we can reduce an error of 10 seconds or 8 seconds to 2.5 and then stop, it appears fair to suppose the error to be owing to the compound laminae, neither of these are really friendly to compensation as they both incline to elongate and the balance of the struggle only produces compensation. Now since the

balance can be timed to a great nicety for 30°. One of my present plans is to make the compound laminae only capable of doing that amount — the rest can be obtained by leverage — this I effect by using the entire circumference of the balance but only $22\frac{1}{2}°$ compensation, the rest a simple metal, either by filing off the brass or steel and strengthened by a ⊥ rib. Should the error still exist then I fear the law of squares will be the difficulty, yet the times are only inverse as the diameters. The present experiment I think will throw some light on this. What a remarkable fact — the old masters at one jump as it were by the happy combination of two metals of different dilitation remedied 390.6 out of 400. No doubt there must exist a remedy for the balance of 1 per cent, yet hitherto it has baffled all our research, no continuous action has produced a gaining in the two extremes, which is a very great object to obtain — a reverse error — perfection would soon follow.

The result of the present experiments, if they do not produce a remedy cannot fail however to throw much light upon the subject; but all kinds of experiments require close following up which is extremely difficult to do and attend to the production of a large number of good watches — being the author of my own improvements, they require a constant supervision and direction and instruction to the workmen — then the financial question and foreign correspondence etc, etc.

I have made a greater number of Vice Chronometer Watches in one year than I suppose was ever done before in 7, They are very costly and consequently admit of very small profit. I often wonder at the eagerness of foreign watchmakers to buy them and how they get a profit. [It is not clear what the word " Vice " means.]

I do now hope to accomplish some satisfactory end and then I must find some means to collect 20 years of continuous experiments of which I have pages of manuscript to put into a tangible and legible form.

Uncompensated Balances

On May 23rd, 1859, Charles sent two chronometers for trial at

the Observatory, one being Arnold No. 943, to which he had applied a plain balance consisting of a bar of platina, and the other being C. Frodsham No. 3148, which had been given a plain brass balance in the shape of an ordinary compensation balance. The idea being " to ascertain if the balance spring does really lose its elastic force equally for equal spaces of temperature ". However, it appears that Airy forgot to explain this to his assistant, Mr. W. Ellis, and on May 30th Charles received a letter from Ellis requesting him to remove these two chronometers, saying that they went very wild and that they were little better than thermometers, the one varying about 6 seconds a day for a degree of Fahrenheit; the other 5 seconds.

On May 31st, Airy wrote to say that one of these chronometers had broken its spring or its chain, and said " In regard to the other, as the object was not explained my assistants did not know how to interpret its rate. Perhaps you can state the object, and state also the expected range of rates ". To which, Charles replied :—

> My object is to obtain their daily variation from your authority for each degree of temperature as near as possible from 60° to 100° in order to decide whether the loss of the balance springs elastic force is perfectly equal for degrees of temperature.
>
> I expect you will find the Chronometer No. 3148 to vary about 6 seconds daily for a change of one degree of Fahr., and No. 943 about 5 seconds under the same circumstances.

But by June 8th, Arnold No. 943 had stopped and Robert Main (first assistant to G. B. Airy) asked Charles to send for it. The next letter from Charles to Airy is dated July 5th, 1859 :—

> I am continuing my experiments with much better satisfaction than the previous ones. I have now investigated the motion of every part of the balance with a view to find out the cause of this constant error. I think I shall make that clear, and that that will suggest the remedy. The motion producing this false centre of motion is less than .00002 of an inch. It would materially assist me if I knew how much less the inverse compensation balance

loses for one degree in heat at 70 to 80 over the lower temperatures you did me the honor to furnish.

P.S I have also succeeded in making a double balance in one by a process of double soldering—this had baffled my previous efforts.

On November 23rd, 1859, Charles wrote to thank Airy for the results of the C. Frodsham, No. 3148 with brass balance showing its daily variation for each degree of temperature; also for the results of the continuation of the chronometer's daily variation with the Inverted Balance. His letter is interesting :—

Amongst the various experiments I have made practical and theoretical by apparently the most opposite means, I still always find the old error of losing in extremes; it was therefore necessary to submit every conceivable motion of the balance to figures and diagrams founded upon the results of calculation etc., etc., and a very remarkable fact turned up, viz, a constant dead motionless point in the compensation laminae at from 15° to 18° from the root caused by the variable radius of the steel arm. I submitted this to a new gauge constructed for the purpose, the point I soon found, viz, at 18°. It was impossible to move this point from 34° to 212°, but to give you a proper rationale that this is the cause of the middle temperature error I cannot yet for my arguments at present seem for and against it.

You will recollect Mr. Effie [Eiffe] recommended a grand compensation bar to the ordinary balance which would shorten in the two extremes. This is a mistake — a steel bar has no inclination to shorten and soldering on to it a piece of brass has no inclination to stop it — the curvature is only from the sum of excess of the brass and must curve some degrees before it shortens, I tried it in the gauge and found it lengthen more than the steel bar. Now the same applies to Mr. Arnold's compensation balance the gauging also proved it and showed the dead and invariable radius on the standards. Now this I have no doubt I shall find the same in the Hartnup Balance, although there is a peculiar construction in the centre arm which tends to shorten in heat and lengthen in cold, I pronounce a priori that where this defect exists perfect compensation cannot be obtained throughout the range of

92°, 62°, 32°. The antagonistic point I have not yet found, but I suspect it. The error in the middle point will I expect to be as the cosine of the dead radius. In order to seek the antagonistic point I have tried a usual Chronometer Balance equal at 90° and 34° and am fitting a brass bar which will naturally remove the dead point further on the laminae and should if my theory be right make the error worse as 1/426 : : 1/526; but I forestall too much which is not complete; but which will be with your permission submitted to you as soon as the rest of the experiments are completed.

The rates of the Inverted Balance that you first drew my attention to will I am sure be data of the utmost importance in obtaining perfect compensation.

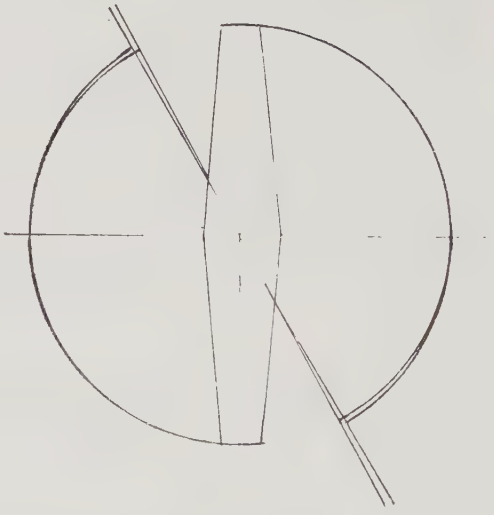
It would appear that the Arnold No. 943, having stopped twice, was replaced with Molyneux No. 5174, which had been given a plain balance. The mean daily rates of C. Frodsham, No. 3148 and Molyneux were sent to Charles in December, 1859, and again on February 25th, 1861, when Airy wrote to say :—

The result shows clearly that the change of rate depending on the altered elasticity of the balance spring is, as far as can be inferred from experiment, exactly proportional to the change of temperature as shown by a mercurial thermometer. From which it seems to follow that the proper correction to the known change of rates at extremes is to be sought in an improved construction of the compensation arms of the balance.

You will however judge best whether the secondary correction is too small to be exhibited in these experiments.

As these experiments will probably suffice for your purpose, I should be glad to discontinue them; as we have much chronometer work on hand.

On March 4th, 1861, Charles wrote to Airy to thank him and to apologise for the delay in writing which was due to ill health. He said the experiments proved that the total error for a change of one degree of Fahrenheit is 6 sec. 13, and wrote :—



The secondary error I do not think can be seen or exists in the chronometer. The cause of the error is beautifully shown in a diagram I have made and proved by a drawing taken in practice from a large model compensation balance that the space or motion of the weight due to a certain number of degrees of heat is wasted by the Balance weight proceeding hypotheneusly instead of direct down the radial line. The diagonal motion appears to be equal to its entire motion, and this error is greatly increased by bad and strong proportions; but no proportions however good can remedy the defect, only reduce it to a minimum.

The Rusting of Blued Steel

On June 5th, 1862, Airy wrote to Captain Washington (who had assisted Dent with his compass experiments) and to the following chronometer makers, Charles Frodsham, John Pennington and Litherland, Davies & Co. To each he said :—

> In examining several chronometers which have suffered much from rust, we have been greatly struck that the rust attacked blued steel (balance spring, screw-head etc.) leaving the white steel (chain etc.) absolutely unaffected.
>
> Do you think that it will ever be possible to produce balance springs with a white surface ?

On June 7th Charles replied to say that he agreed with Airy's observations, and considered it well worthwhile to try making the balance springs white and suggested that perhaps a good simple gum varnish would adhere better and present a better appearance with

such springs. Eventually, on August 20th, 1862, he wrote to Airy to say :—

> In reply to your note respecting white balance spring, I propose to use them to two Government Chronometers I have reported for new Balance Springs. My own experience on Balance Springs is that they rust much more in the Navy than in the merchant service, which doubtless arises from the greater exposure to damp from the number of persons on board and the port holes. The old plan of capping these Chronometers I consider should be returned to. The attempt at hermetically capping I found to fail. I will also prepare some new Chronometers with these springs so capped which with your consent I will offer to the Admiralty for sale at a moderate price.
>
> I have been absent from business the last few days with an old lung complaint which has prevented my reply to your note before.

Airy then asked Charles to prepare two small engraved plates with the words *Experimental bright springs*, and to fix them to the lids of the boxes.

As to which chronometers were used for this experiment, and what the outcome was, there seems to be no record. Incidentally, a gilt metal balance spring is to be seen in a free-sprung, lever, reversed fusee, pocket watch No. 101397. H.M. 1860.

Let us leave the Airy correspondence for the moment and return to the main story.

Telford Medal

In 1846 Charles was made an associate member of the Institution of Civil Engineers. A condition of membership was that the new recipient of this honour should, as soon after election as possible, read a paper before the Members of the Institution. Charles delivered his lecture on the 27th April, 1847, it was entitled : *On the Laws of Isochronism of the Balance Spring as connected with the higher order of Adjustments of Watches and Chronometers.*

Following the lecture there was a lengthy discussion which extended over portions of two evenings. The whole of this was published as a pamphlet of 33 pages, half of which were devoted to

the discussion consisting of remarks by Mr. Farey and Mr. Vulliamy with Frodsham's replies.

The gist of this lecture is summed up in a paragraph which reads as follows :—

> Of all the adjustments necessary in the parts of a good watch, the most essential to its performance is unquestionably that of the isochronism of the balance spring; for, if this adjustment be wanting, whatever may be the excellence of the machine in other respects, and however laboured its workmanship and other adjustments, it will assuredly disappoint the expectation of the artist, who will find it incapable of being regulated to preserve the same rate of going, in the various positions in which it is liable to be placed.

He commenced by pointing out that supposing a watch is found to keep correct time in the four vertical positions, i.e., with XII, VI, IX and III consecutively upwards (with the friction increased in the vertical positions and the arc of vibration therefore smaller), but that in the horizontal position with the face upwards (with less friction and therefore longer arcs) the watch gains 2 minutes in 12 hours; here then is a watch gaining considerably in the long arcs in the horizontal position but correct in the vertical positions, showing that the watch has been correctly poised. The proper remedy in such a case is to make a correct isochronal adjustment of the balance spring. A person unacquainted with this adjustment would follow the plan usually resorted to, in which by lightening the balance at the XII o'clock part the times of vibration in the hanging and lying positions of the watch may be accommodated to each other; but not without incurring errors in the other three vertical positions.

He then discussed the history of the adoption of the balance spring and suggested that in order to understand isochronism one must examine the " accelerated and retarded motion of the balance ", by which I think he means that when the spring is opened it gives an acceleration to the balance, and then, on becoming compressed the spring retards the motion of the balance. He suggests that there are two types of balance springs which do not produce isochronous vibrations, one which is too strong and the other which is too weak.

In order to try the isochronism of the spring, a chronometer must be in going order. Then if the force of the main spring be increased by setting up the ratchet, the arc of vibration of the balance will be increased, and vice versa. Comparison of the chronometer's rate of going, during an equal number of hours, in the long and short arcs of vibration are then made by a good clock, and the difference, if any, noted. This difference indicates the state of approximation of the spring to isochronism, and points out the remedy, if needed, according to the following rules :—

1. If the chronometer loses in the long arcs, shorten the helical spring. This can be done artificially (if the error is not too great) by merely altering the form of the upper curve of a helical spring, so as to give it a greater degree of expansion.

2. If the chronometer gains in the long arcs, the remedy would be to increase the length of the part in action. An artificial length is given to the spring by compressing the curve of the part bent inward at the upper end, so as to make the curve commence its inward direction at a point a little farther from the stud.

The opinion of the early writers was, that a certain determinate length procured an isochronal spring; but the fact is, that in every length of wire there are several isochronal points, to any one of which a balance may be adapted, according to the nature of the vibrations it is intended to perform.

In the case of a flat or spiral spring the principles upon which its isochronism depends are not altered.

A spiral, to be turned up correctly, should lie in several close turns towards the centre, springing off by a gentle curve from where it is pinned into the collet and thence gradually and constantly expanding, in such a manner that each part of the spiral would cross, but nowhere coincide with, a smaller circular arc drawn from the centre of the collet and concentric therewith. This is indispensible for isochronism. The indications and the application of the isochronal adjustment are the same as those already described for cylindrical (helical) springs, but under greater restrictions. He suggests that the selection of a spring, within the limits of the isochronal adjustment, must therefore be made by trial in a watch.

He does not give any precise method for curing a watch which gains in the long arcs, i.e., when lying face upwards.

It must be pointed out that the above remarks are simply a summary of the more important points in the lecture. The lecture was considered to be so excellent that the Institution of Civil Engineers awarded Charles the Telford Medal.

Greenwich Time

Nowadays we take Greenwich Time for granted, but, when it was first suggested that it should be introduced, the public in general were by no means willing to surrender the use of local time. So, it became necessary to convince everyone that the adoption of Greenwich Time was commonsense. One of the people who wrote in favour of its adoption was Charles Frodsham who published in 1848 a small booklet entitled *Greenwich Time. The Universal Standard of Time throughout Great Britain.*

He explains that with the advent of the railways the use of local time had caused great confusion in railway traffic. The managers of the principal railways radiating from the metropolis, considered the matter and decided to adopt Greenwich Time as the standard for all their clocks which had been set up in their stations. This became known as " Railway Time ". These clocks, of course, differed from the town clocks which showed local time. Town clocks west of London would be slow by about one minute for every ten miles of westing, and those east of London would be fast by about one minute for every ten miles of easting. Watches were therefore produced having separate dials for " Railway Time " and " Local Time ", this must have helped the general public to some extent, quite apart from helping watchmakers from a financial point of view.

It is interesting to find that the Scots were the first to have the commonsense to adopt the new standard time. On the 13th January, 1848, the authorities of Edinburgh set all their town clocks to Greenwich Time.

However, in March, 1848, an article was published in *Blackwood's Magazine* condemning the measure, and it was as a reply to this article that Charles Frodsham wrote a letter to the Editor of one of

the public journals, and this was later published in a booklet. He said :—

The author of the article in question, when he makes the assertion that, " Perhaps our excellent councillors are not aware that there is no such thing as a universal time ", seems for the moment to have forgotten that what is known to astronomers under the term *mean equinoctial time* is universal, both in its nature and application. At page 631 of the Nautical Almanac for the present year (1848), we read : " This species of time was first introduced in the Supplement to the Nautical Almanac for 1828, with a very full explanation of its nature and use. It there appears, that the use of equinoctial time is to afford an uniform date, which shall be independent of the different meridians, and of all inequalities of the sun's motion, and shall thus save the necessity, when speaking of the time of any events happening, of mentioning at the same time the place where it was observed or computed. Thus, it is the same thing to say that a comet passed its perihelion (the point of the orbit at which it is nearest to the sun) on January 5th, 1848, at 5h. 47m., mean time at Greenwich; at 5h. 56m. 21.5s. mean time at Paris; or at 1847 y. 288d. 14h. 19m. 57.75s. equinoctial time; but the former dates make the localities of Greenwich and Paris enter as elements of the expression; whereas the latter expresses the period elapsed since an epoch common to all the world, and identifiable independently of all localities." [The equinoxes being, of course, the two days in the year, March 21 and Sept. 22, when the days are equal to the nights all over the world; the former being used for the above calculation.]

The writer in Blackwood having fallen into the error just alluded to relative to universal time, is unwittingly drawn into another relative to the tontine lives mentioned at p. 358 of the same paper. The facts of the case are, that about £5,000 tontine accumulation are at stake between two parties, the issue of which is dependent upon the survivorship of the two remaining nominees, of whom one, M'Tavish, is resident at Greenwich, and the other, Hutcheon, located at Edinburgh. A case of their demise is then supposed, which I shall relate in the author's own words : " Both (the interested parties) have taken effectual measures to have the

death of his neighbour's nominee noted with accuracy to a second. Now, if Hutcheon were to die today in Edinburgh, and if the next post brought intelligence that M'Tavish had given up the ghost at Greenwich precisely five minutes sooner, which of us two would be entitled to the stakes ? On the 29th January, when the old and true time was in observance, there could have been no doubt about the question. We should have been the winner by $7\frac{1}{2}$ minutes. Hutcheon would have died, like his forefathers, at $7\frac{1}{2}$ minutes after eleven, and M'Tavish at a quarter past. But, as it is, the life of M'Tavish has been cut short, or what is the same thing, that of Hutcheon has been preposterously prolonged. And so, if the alteration of the Town Council be legal, we may be defrauded of £5,000."

Now, if we lay aside the mystification in which the former part is involved by the latter, the case may then, be treated (as it ought to be) as one of order and absolute time, not relative time, as noted by the assumption of that of different meridians; for the stream of time flows on uninterruptedly, and the order of events as they transpire must be referred to the same identical standard; and accordingly, we find that M'Tavish expired by Greenwich Time at a quarter past eleven, and Hutcheon at twenty minutes past eleven by the same time. Hutcheon was, therefore, the survivor by five minutes; and it will be impossible by any sophistry to alter the order of their demise. The adoption of Greenwich Time would effect the decision as positively as a person who, from an elevated position, could at the same moment view all that was passing in the two chambers, and note, by the same watch, the times at which the two persons successively expired.

The booklet continues by pointing out that very few sun-dials have been constructed for the latitude of the place at which they are used, and that in any case sun-dials show unequal or apparent time, so that to obtain the necessary correction one has to use the equation of time. In the same way the necessary correction can easily be made for difference of longitude.

By the time the booklet was ready for publication a number of towns had adopted Greenwich Time.

The Aneroid Barometer

A booklet dealing with barometers was published in 1849 by Charles Frodsham. (E. J. Dent had already produced a booklet in 1848.) In this Charles described and illustrated his 5 inch aneroid barometer and pointed out its use for showing atmospheric changes and for measuring heights and differences of level. He also pointed out that the instrument is liable to a small error due to change of temperature. He provided a useful chart to show this error. He also pointed out that another way to estimate heights is to note the temperature at which water boils, for example water boils at 180° at the top of Mont Blanc due to the lower barometric pressure.

The last eight pages of this thirty-page booklet are devoted to *Remarks on the Mercurial Barometer*, by P. Christensen, who points out that :—

> Although the perpendicular column of the atmosphere may be heavy enough to support even thirty inches of mercury, yet the lower region may be so rarified as to allow the vapours to descend; in still weather the mutual attraction will increase the size of the drops in their descent, but in this case a diligent observer will have timely notice by the upper part of the mercury becoming CONCAVE. On the contrary, the atmospheric column may be too light to support twenty-nine inches of mercury, and yet the lower region may be condensed to a degree sufficient to keep the vapours in a state of buoyancy; this may be known by the surface of the mercury becoming CONVEX.

So that, by selling aneroid barometers Charles was developing a sideline, just as E. J. Dent had done, and as we shall see this was not to be the firm's only sideline.

AD Fmsz

These letters are to be found on the back plate and on the dial of some of Charles Frodsham's watches. The earliest known number to have this lettering is No. 6949, and the next is No. 7464 with hall-mark for 1852; both have "Arnold, Charles Frodsham " on the dial, and " Chas. Frodsham, 84 Strand ", on the back plate.

The Fmsz, with AD in front of it obviously stands for a date, and using the letters of the name Frodsham we have :—

F R O D S H A M
1 2 3 4 5 6 7 8

which gives us Fms = 185 and the question is, what does the z stand for ? Chamberlain states that James Ferguson Cole's son told him that it stood for " 9 ", i.e., 1859 when Cole designed a new range of watches. But in view of the above hall-mark and the fact that Charles had produced his own new calibre (as described below) in 1850, there is no doubt at all that the " z " indicated zero, and that Fmsz stands for 1850, i.e., the date when he " commenced " to make high quality watches.

The Great Exhibition of 1851

Charles Frodsham exhibited marine chronometers and pocket chronometers having a new calibre. The former were described in the exhibition catalogue as follows :—

The Marine Chronometers' Calibre

Arnold & Earnshaw's detached escapement.

An ordinary balance with Arnold's bar as auxiliary compensation. The diameter of the barrel, fusee wheel and the extreme diameter of the balance are the same, namely one and five-tenths inches. The total weight of the compensation balance is 5 dwts [pennyweights], being as the contents of the barrel. Thus if a barrel, one inch in diameter, by three-tenths of an inch in depth, will carry a balance weighing 20 grains, a barrel of the same diameter, and of double the depth, will carry a balance weighing 40 grains. [1 pennyweight = 24 grains of troy weight, i.e., the weight of a silver penny.]

The balance-spring is 15 inches long; the diameter 45/100, the thickness of wire 10/1000 by 18/1000 broad, and the number of turns 10 to 12.

The wheels (escape-wheel included) are each five times the diameter of their respective pinions — that is, the pinion upon which the wheel revolves. The fusee-wheel has 90 teeth, centre

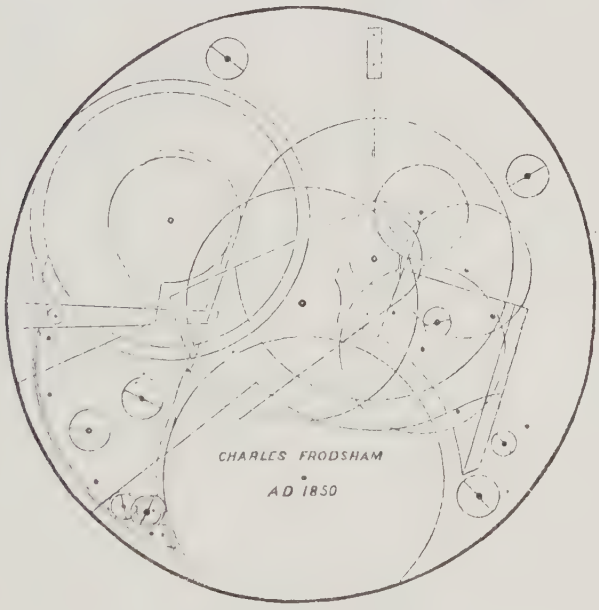
wheel 90, centre pinion 14, third wheel 80, third pinion 12, fourth wheel 80, fourth pinion 10, and 'scape pinion 10, 'scape-wheel 15.

One point of interest. It should be noted that this is the first written record of the use by Charles Frodsham of an ordinary balance with Arnold's bar attached to it. However, as already mentioned, a marine chronometer signed John R. Arnold No. 451, and inscribed " Restored by Charles Frodsham, 1845 " has this style of balance, which strongly suggests that Charles was using this type of combined balance in 1845 or earlier.

A number of these balances would appear to have been made, and then Charles began to experiment with a variety of balances on the same principle.

A variety of watches were exhibited, such as :—

a. **Gold pocket chronometers and lever watches**

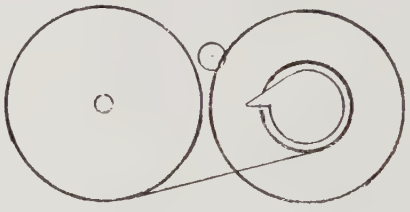


Frodsham's new Calibre for Watches.

These watches were similar in design to the above marine chronometer, differing only in that the new calibre was reduced in size.

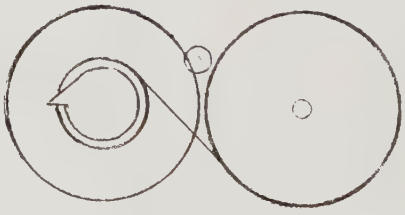
Reversed Fusee

It will be noticed that, in the new calibre, the fusee is reversed. By a " reversed fusee " one means that the fusee has been placed on the opposite side of the watch (as one views it from the back) to the normal position. The fusee chain can be seen to pass diagonally between the barrel and the fusee (see diagram). The idea being to lessen the friction on the fusee arbor. Mudge had already used this type of lay-out. It is interesting to note that Kullberg came to London for the first time in 1851 when he wished to see the Crystal Palace Exhibition, and it would appear that it was after this that Kullberg adopted the reversed fusee (which is a characteristic of his movements), having, one assumes, considered Frodsham's principles to be excellent.



Normal fusee

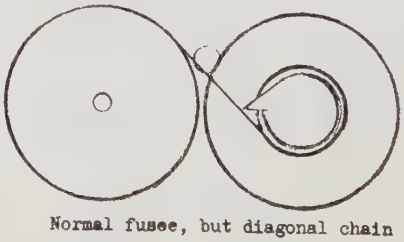
If the object is simply to make the fusee chain pass diagonally, why bother to reverse the positions of the barrel and the fusee ? I must admit that this puzzled me until I made a drawing of the fusee in the normal position but with the chain passing diagonally, as in the lower sketch, where it can be seen that the chain will pass too close to the centre wheel arbor.



Reversed fusee

The reversed fusee should not be confused with the " inverted fusee ", where the fusee is upside down.

As already mentioned, Mudge had used a reversed fusee as early as 1774, but other makers had also used it before Charles Frodsham, for example, Barraud had been using it in 1810, as in No. 482, and again in 1820 as in No. 982, both 8-day chronometers. John Roger Arnold would also appear to have used it on at least one occasion. There is a most interesting little 8-day marine chronometer with the



Normal fusee, but diagonal chain

name " Arnold " on its dial, but no number on either the dial or the movement. It is housed in a box bearing the name *Arnold* and the number 366, but the style of the dial is obviously later than 1811 when No. 366 would have been made. (Curiously enough there is also in existence another one-day chronometer numbered " 366 " which fits in perfectly with the Arnold series in having an Arnold detent and a going barrel.) There are several points of interest in this mysterious chronometer; it is unusually small for an eight-day movement, it has a reversed fusee and, most surprisingly, the balance beats half-seconds, and the seconds hand beats seconds, as noticed by Martin Ball. It has an Earnshaw detent and screw-type balance, and no sign of having had an Arnold detent. The cock is screwed together at its angle (as in the two Barraud chronometers already mentioned).

This, of course, raises a number of questions; did Arnold make this chronometer and, if so, when did he make it, the dial could, of course, be a later addition ? Arnold's 8-day chronometers normally had an Arnold detent and normal fusee, but after the break-up of the Arnold - Dent partnership, John Roger did use an Earnshaw detent and a screw-type balance as his standard type, but there is as yet no other record of his using a reversed fusee. Who made the 8-day Barraud chronometers ? Could they have been made by Arnold to Barraud's design ? Could the Arnold one have been made by Charles Frodsham as a trial piece, prior to 1850 ? If so, then almost certainly it would have had Frodsham's name on it as well as Arnold's.

It seems probable that Charles Frodsham, realising the correctness of the reversed fusee, adopted the idea from Arnold and from Barraud, and introduced it as part of his new calibre.

b. A Day-of-the-Month Watch

This had a lever escapement and double roller. The calibre was a more simple one than the new calibre and closely resembled the type previously used by Charles but differing in that the number of teeth in the wheels is peculiar : The centre wheel is much enlarged, with 100 teeth working in a pinion of 10 leaves. The third wheel is

diminished and has 60 teeth working in a pinion of 10. The fourth wheel has 63 teeth working in a pinion of 7.

All measurements are in inches and 1/1000 of an inch, and not in technical sizes.

c. **Split Centre Seconds-Hand Watches**

These watches were accurate to a quarter of a second. Their action is described in detail in a pamphlet entitled *" Description of Charles Frodsham's Register, or Split Centre Second's-Hand Watch"*, together with a separate sheet entitled, *" Companion to Charles Frodsham's Register"*, the latter is, in fact, a table to show the number of miles per hour in reference to the time taken to run the distance of a quarter of a mile. These two sheets are reproduced, in a larger scale than the original, on pages 325 and 326. Put in simple terms, supposing one wishes to time a race, then, at the start of the race, the registering hand (the under hand) must be stopped, the time noted, the spring released thereby allowing the registering hand to join the revolving hand, so that the two hands revolve together until the end of the race when the registering hand is again stopped and the time recorded. By subtracting the first record from the last, one has the time taken for the race.

d. **The Double Rotary Escapement**

This is a specimen of a new calibre movement by which a powerful watch may be made in a flat case.

It is curious that E. B. Denison (who was the Juror for the horological section of the Exhibition) made no mention of this watch in his report.

It would seem that this watch must have been one of the watches signed " J. F. Cole, Charles Frodsham, Arnold, 84 Strand ". James Ferguson Cole being the one responsible for the design of these watches.

Cole's Double Rotary Duplex Escapement

In 1840, J. F. Cole made a marine chronometer with a double rotary spring detent escapement. It is now in the possession of the Clockmakers' Company and is signed " James F. Cole, Invt. London,

A.D. 1840. Double Rotary Detached Escapement ". This chronometer is described in Gould's *Marine Chronometer*, page 139. See **Plate 30**, page 372. The discharging pallet is carried on a separate arbor and geared to the balance staff in the ratio of 2 to 1. There is, therefore, a constant friction between the teeth of the discharging wheel and the leaves of the pinion on the balance staff. Not a good idea. (It reminds one of the rack lever escapement.) This chronometer has a flat balance spring with overcoil of four turns, a going barrel and is of three-day duration.

An example of Cole's double rotary duplex escapement is described by Robert Burnett on page 506 of *Antiquarian Horology*, September, 1970. Could this have been the one exhibited in 1851 ? It is inscribed " Designed and Made by J. F. Cole. Chas Frodsham Arnold 84 Strand London. No. 1 N.S." and has the hall-mark probably for 1849. The lay-out is as follows :—

The fusee wheel has 96 teeth and drives the centre wheel pinion with 12 leaves.

The centre wheel has 80 teeth and drives the third wheel pinion with 10 leaves.

The third wheel has 75 teeth and drives the fourth wheel pinion with 10 leaves.

The fourth wheel has 72 teeth and drives the fifth wheel pinion with 7 leaves.

This fifth wheel is in effect the escape wheel and has 60 wolf teeth. Every fifth tooth has a short upwards projection. The teeth of this wheel drive a pinion of 10 leaves which carries a two-armed gold fly. This fly locks against a slotted jewelled roller on the arbor of an intermediate wheel (C). This wheel has 30 teeth which engage with a pinion of 15 leaves on the balance staff — a 2 to 1 ratio. The wheel (C) therefore rotates to and fro with the balance. When the tip of the fly enters the slot on the roller, the fly is released to complete its half rotation, thereby allowing the escape wheel to move forward 5 teeth so that the appropriate upraised tooth can give impulse to the pallet on the staff of the balance. This watch

possesses a means of locking the fusee wheel, we shall see why this is necessary when we discuss the next example.

Gazeley described another example of this escapement in *Clock & Watch Escapements*, page 167. This differs slightly from the last one in that the 60-tooth escape wheel has upright teeth on every fourth tooth and therefore the pinion carrying the fly has only eight leaves. The intermediate wheel has but 20 teeth and engages with a pinion of 20 leaves on the balance staff. A ratio of 1 to 1 seems rather odd since the whole idea of the 2 to 1 ratio would seem to have been to lessen the danger of tripping, according to Gould. Many years ago, when discussing this particular watch with me, Gazeley pointed out that the centre wheel has to be removed in order to take out the balance, but that before removing the centre wheel, the fusee wheel must be locked; I do not know whether Gazeley's watch has a gadget for locking the fusee wheel, but this is the reason for the one found by Robert Burnett in No. 1 N.S. Incidentally, Gazeley's example has, as far as I know, no number. **Plate 30**, page 372.

Two further examples of Cole's double rotary duplex are known :—

No. 02408. Chas. Frodsham, 84 Strand, London. H.M. 1865. Gold case. $\frac{1}{2}$-plate, free sprung, with Up & Down indicator.

No. 03526. Chas. Frodsham, 84 Strand, London. H.M. 1866. $\frac{3}{4}$-plate.

Charles was awarded a first-class medal for his exhibits in the 1851 Exhibition at the Crystal Palace.

By now Charles was acknowledged to be one of the leading chronometer and watch makers of his time. His portraits are shown in the **Frontispiece** and in **Plate 31**, page 373.

James Ferguson Cole

As already mentioned, Cole had been associated with Charles in the production of the double rotary escapement; it has been suggested that Cole was also in part responsible for Frodsham's new calibre. There is, however, as far as I know, no evidence for or

against this possibility. Until it is proved otherwise it seems fairer to give Charles the benefit of the doubt.

It is obvious that Charles was on intimate terms with Cole, as pointed out by Chamberlain who was given a number of letters written by Charles in 1867 from the Paris Exhibition. The letters were given to Chamberlain by Cole's son.

The Spanish Pamphlet

In about 1852, a special pamphlet was published in Spanish, its author being Charles Frodsham.

No copy of this document, which was in fact an advertisement, has been found, but, by great good fortune, a copy of a translation of the original has been traced. This translation was probably made by Malcolm Gardner (who spoke fluent Spanish), in collaboration with a Mr. Moon, when they were preparing their notes for a work to be entitled *"Some Aspects in the Evolution of the Pocket Chronometer, as recorded in the History of Charles Frodsham & Co. Ltd. with a Chapter on the Vulliamy"*. This was never published but some of the original notes were lent to me by Charles Allix a number of years ago; these contained a brief reference to the Spanish pamphlet. The final version of this history appears to have been made by Philip Clowes, and, as mentioned in the Introduction to this book, his notes were handed over to Frank Thirkell. This is the source of the translation of the Spanish pamphlet which now follows :—

Arnold's. 84 Strand.

Improvements in Watches based on Experience with the Chronometer.

Following the advice of various friends in India who have appreciated my improvements in the construction of watches and have earnestly recommended me to make their results more generally known, I have decided to publish this circular in order to dispel the difficulty of knowing where, and particularly at what cost, one can obtain a good watch suited to the circumstances and climate of Spain and the Indies.

For some years I have had charge of the business of the late Mr. John Roger Arnold, and being well known as a maker of Chronometers, my predecessor's friends honoured me with their complete confidences. I felt, however, that no ordinary work on my part was necessary to maintain the credit of an establishment which under the two Arnolds, father and son, had enjoyed for the long period of 80 years the distinguished patronage of the nobility and the public in general.

I had previously devoted myself for many years to the construction of Chronometers, and in 1830 I showed for a public test in Greenwich two Chronometers, for one of which the British Government saw fit to grant me the prize of £170; its greatest variation of rate was only 54/100 seconds in 12 months of daily observation; that of the other, only 86/100 seconds. The success of my Chronometer was so great that, purely on the recommendation of those who need them, they are now found aboard ships of all nations navigating all the seas of the globe.

Accustomed, then, as I have long been, to the precision of a Chronometer, it caused me great annoyance to find the watch in comparison with the Chronometer, generally very far from the perfection attainable and of which it was capable — here, then, I found my future field of action and I resolved to apply myself to its improvement because a general complaint had been that a good marine Chronometer could be obtained for the sum of 40 or 50 guineas while the purchase of a watch was a casual matter; a particular price would not buy a correspondingly good watch. There seems little doubt that the construction of watches in general had been neglected owing to the very interesting construction of marine Chronometers. The Greenwich trials and prizes, the honour accruing to the success combined with the pecuniary advantages, were too powerful inducements for talented watchmakers, who were the only ones who could compete, to resist. Nevertheless, however important might be the construction of the marine Chronometer, I consider that in these days of punctuality and railway speed, a good pocket watch at a moderate price is equally important; after numerous experiments, then, accompanied by considerable work and study, I reached the point where the only way of improving the

watch was to adapt the proportions, routine and adjustments of the marine Chronometer. Taking, therefore, my prize Chronometer for a model, I made a number of Chronometers and pocket watches of all sizes and descriptions and called them by the distinguishing name of " My new series ". Their proportions being strictly chronometrical, they were entirely opposite to those of the best modern make; experience, however, has proved that they possess the double advantage that they are improved as astronomical watches and also allow me to include in the given space a movement four sizes bigger than usual, producing thus a more useful and a smaller watch. In correct proportions lies a complete resolution of the uncertainty which previously accompanied the purchase of a watch. It is plain that they are the result of experience and not of expense and can therefore be applied to the cheapest watch with as much advantage as to the most costly.

The whole system was shown in my office or stand in the Great Exhibition of London in 1851 and attracted the attention of foreign judges in particular, one of whom was pleased to say that I had done more for the advancement of watchmaking than had been done in the previous 40 years; and the following opinion expressed in one of the numerous French reports on that part of the Exhibition referring to watches will show the spirit in which the French watchmakers who are our rivals have seen my improvements.

Borsendorff, in " La Loupe ", published in Paris, after commenting on the products of many other exhibitors goes on to say : " However, I saw with the greatest pleasure the exhibit of Mr. Charles Frodsham, of London, which consists of three marine Chronometers and seven handsome pocket Chronometers, which are the flower of the English school and in fact bear the stamp of its peculiar style and excellence ".

My new watches are particularly adapted to suffer the violent motion of horse riding, hunting, etc. and at the same time approximate so closely to Chronometric precision that many of them have maintained rates not inferior to that of the best Chronometers.

I think it my duty to my friends and the public to explain at greater length the nature of the improvements I have made, but such details would be impossible within the limits of a circular; the

results, however, can easily be gauged from the many testimonials I have received, and of which I append a few.

CHARLES FRODSHAM

Successor to the late J. R. Arnold.

No. 1.	Gold	Watch — Hunter		£26. 5.0d.	Silver	Hunter	£ 7. 7.0d.
2.	,,	,,	,,	31.10.0d.	,,	,,	10.10.0d.
3.	,,	,,	,,	39.18.0d.	,,	,,	14.14.0d.
	Gold	Hunting	Chronometer	68. 0.0d.	,,	,,	16.16.0d.

Although I have stated the price of the gold Chronometers, I do not consider them so well suited for general use in Spain and in the Americas (unless they are required for astronomical purposes) as watch No. 3. which will be found in practice to be equally exact.

No. 1 and No. 2 have given great satisfaction and, according to the most flattering reports I have received of their rates, appear admirably suited to the climate.

It is requested that when orders are sent they bear clearly the number and name of the watch and that the order is accompanied by a remittance or Order against a Banker, Merchant or Agent, when the watch ordered will be sent at once, free of freight and insurance charges, to its destination, with spare Regulator, glasses, keys, etc. which is equivalent to a liberal discount for cash payment.

26 Upper Bedford Place, Russell Square

84 Strand had been not only the place of business but also, as far as is known, the residence for Charles and Elizabeth and their children, who, in 1854, were nine in number. It is therefore not surprising that they all moved in that year to 26 Upper Bedford Place, leaving 84 Strand to be used completely as business premises. Charles and his wife continued to live at Upper Bedford Place until the end of their lives.

Benjamin Lewis Vulliamy, 1854

Vulliamy and Charles Frodsham were both members of the Institution of Civil Engineers; they became great friends and

Charles frequently visited Benjamin at 68 Pall Mall. Benjamin had gathered together a wonderful collection of horological books and pamphlets and these, together with his collection of prints, formed a very fine library which was much appreciated by Charles. This library was later bequeathed by Vulliamy to the Institution of Civil Engineers.

In 1849, Benjamin, who owned two pedometers made by his great-grandfather, Benjamin Gray, decided to present one of them to the Clockmakers' Company, and to give the other one to Charles Frodsham, this one bears the following inscription, " Made by B. Gray, Clockmaker to George 2nd. Given to Charles Frodsham by his great-grandson B. L. Vulliamy 1849 ". Five years later Benjamin Lewis Vulliamy died on the 8th January, 1854, and, since his sons were not interested in the business, Charles was able to purchase the goodwill. The question then arose as to who should now have the honour of being made : *Superintendent of the Clocks at the Royal Palaces.*

Vulliamy's great-grandfather, Benjamin Gray, received the Royal Warrant in 1742 and became Clockmaker to George II. The Royal Warrant had been granted to the Vulliamys and in addition Benjamin Lewis had been made " Superintendent ". In due course Charles Frodsham was given this honour, probably largely on the advice of Airy (see *Edward John Dent*, pages 670 - 672). The House of Charles Frodsham still retains the honour of being " Superintendent of the Clocks of the Royal Palaces ".

Gold Medal of Honour, 1855

Charles received this award at the Paris Exhibition of that year.

" A Few Words to do Justice to English Chronometer, Watch, and Clock Making "

In the *Horological Journal* for June, 1860, page 133, there are two letters, one from S. Long addressed to J. F. Cole, and the other Cole's reply. Long claimed to have invented a variation of the compensated balance in about 1832, but Cole claimed that he had invented a similar balance in 1842.

These letters prompted Charles Frodsham to reply in a series of articles, having the above title. The first was published in the *Horological Journal* for July 1st, 1860, page 150.

In this he says :—

> The Arnold compensation balance is perfect for all practical purpose for a range of 30 degrees of temperature — say, between a temperate climate and a torrid zone. There is not a spot on the globe where at sea the temperature exceeds 85° at fifteen feet above a ship's deck, and a ship's cabin seldom exceeds 80° to 87°, the mean temperature of the navigable ocean ranging from 50 to 80 degrees.

It must be pointed out that the " Arnold " balance was in fact the balance we now refer to as an " Earnshaw " balance. In praise of this balance he says :—

> I can only say, that unless a compensated balance of equal simplicity to the present one can be found, I would never recommend its application. . . .
>
> The balance which Mr. Cole calls a " non-resisting balance " is one of John Arnold's early plans; but as it is not likely ever to be put in practice, I need make no remark upon it beyond this, — that resistance is essentially the base of compensation. Compensation is effected by one metal resisting another; this resistance is equal and contrary — if it resists in going in, it equally resists in going out.

On page 158 the *Horological Journal* published *Charles Frodsham's General Table of Trains.* He explained that in the Table :—

> The Diameter and Weight of the Balance are apportioned to the Velocity upon the supposition that the watch has the same momentum — that is, that it does the same amount of work, and may be driven by the same identical mainspring (in a barrel of 65 hundredths of an inch diameter and $13\frac{1}{4}$ hundredths deep) and with the same identical balance spring; the law being that the weights here given may be changed for a variety of others, provided the weight be increased or diminished in the inverse

CHARLES FRODSHAM'S GENERAL TABLE OF TRAINS,

From 240 to 400 Vibrations per Minute.

*** *The measures are in hundredths of an inch, and the weights in grains.*

Model.

VIBRATIONS. Per Hour.	Per Min.	Per Sec.	Accord with Clock.	Escapement Wheel Teeth.	Ratio of Escapement Pinion to Fourth Wheel.	Diameter constant.	Weight variable. In Grains.	Weight constant.	Diameter variable. In 100ths.	* Both variable. Weight.	Diam.	BALANCES.
14,400	240	4	4 *v.* = 1″	12	1 to 10	65	11·34	9	73	$10\frac{1}{4}$	$68\frac{1}{2}$	
,,	,,	,,	,,	15	1 ,, 8	65	11·34	9	73	$10\frac{1}{4}$	$68\frac{1}{2}$	
,,	,,	,,	,,	16	2 ,, 15	65	11·34	9	73	$10\frac{1}{4}$	$68\frac{1}{2}$	D. $68\frac{1}{2}$
,,	,,	,,	,,	18	3 ,, 20	65	11·34	9	73	$10\frac{1}{4}$	$68\frac{1}{2}$	W. $10\frac{1}{4}$ grs.
,,	,,	,,	,,	20	1 ,, 6	65	11·34	9	73	$10\frac{1}{4}$	$68\frac{1}{2}$	
15,000	250	$4^{1}/_{6}$	25 *v.* = 6″	15	3 ,, 25	65	10·48	9	$70\frac{1}{4}$	$9\frac{3}{4}$	$67\frac{1}{2}$	
15,120	252	$4^{1}/_{5}$	21 *v.* = 5″	14	1 ,, 9	65	10·32	9	$69\frac{2}{3}$	$9\frac{1}{2}$	$67\frac{3}{4}$	
,,	,,	,,	,,	18	1 ,, 7	65	10·32	9	$69\frac{2}{3}$	$9\frac{1}{2}$	$67\frac{3}{4}$	
†15,360	256	$4^{4}/_{15}$	64 *v.* = 15″	16	1 ,, 8	65	10·00	9	$68\frac{2}{3}$	$9\frac{1}{2}$	$66\frac{2}{3}$	
15,600	260	$4^{1}/_{3}$	13 *v.* = 3″	13	1 ,, 10	65	9·70	9	$67\frac{1}{2}$	$9\frac{1}{4}$	$66\frac{3}{4}$	
,,	,,	,,	,,	20	2 ,, 13	65	9·70	9	$67\frac{1}{2}$	$9\frac{1}{4}$	$66\frac{3}{4}$	
15,660	261	$4^{7}/_{20}$	87 *v.* = 20″	18	4 ,, 29	65	9·62	9	$67\frac{1}{3}$	$9\frac{1}{4}$	$66\frac{1}{2}$	
15,840	264	$4^{2}/_{5}$	22 *v.* = 5″	18	3 ,, 22	65	9·40	9	$66\frac{1}{2}$	$9\frac{1}{4}$	$65\frac{2}{3}$	
16,200	270	$4^{1}/_{2}$	9 *v.* = 2″	15	1 ,, 9	65	9·00	9	65	9	65	D. 65
				18	2 ,, 15							W. 9 grs.
16,320	272	$4^{8}/_{15}$	68 *v.* = 15″	16	2 ,, 17	65	8·87	9	$64\frac{1}{2}$	9	$64\frac{1}{2}$	
,,	,,	,,	,,	17	1 ,, 8	65	8·87	9	$64\frac{1}{2}$	9	$64\frac{1}{2}$	
16,560	276	$4^{3}/_{5}$	23 *v.* = 5″	18	3 ,, 23	65	8·60	9	$63\frac{2}{3}$	$8\frac{3}{4}$	$64\frac{1}{2}$	
16,800	280	$4^{2}/_{3}$	14 *v.* = 3″	15	3 ,, 28	65	8·36	9	$62\frac{2}{3}$	$8\frac{3}{4}$	$63\frac{1}{2}$	
,,	,,	,,	,,	16	4 ,, 35	65	8·36	9	$62\frac{2}{3}$	$8\frac{3}{4}$	$63\frac{1}{2}$	
,,	,,	,,	,,	20	1 ,, 7	65	8·36	9	$62\frac{2}{3}$	$8\frac{3}{4}$	$63\frac{1}{2}$	
17,280	288	$4^{4}/_{5}$	24 *v.* = 5″	16	1 ,, 9	65	7·90	9	61	$8\frac{1}{2}$	$62\frac{2}{3}$	
,,	,,	,,	,,	18	1 ,, 8	65	7·90	9	61	$8\frac{1}{2}$	$62\frac{2}{3}$	
17,340	289	$4^{49}/_{60}$	289 *v.* = 60″	17	2 ,, 17	65	7·85	9	$60\frac{2}{3}$	$8\frac{1}{2}$	$62\frac{1}{2}$	
17,400	290	$4^{5}/_{6}$	29 *v.* = 6″	15	3 ,, 29	65	7·80	9	$60\frac{1}{2}$	$8\frac{1}{2}$	$62\frac{1}{3}$	
,,	,,	,,	,,	20	4 ,, 29	65	7·80	9	$60\frac{1}{2}$	$8\frac{1}{2}$	$62\frac{1}{3}$	
18,000	300	5	5 *v.* = 1″	12	2 ,, 25	65	7·28	9	$58\frac{1}{2}$	$8\frac{1}{4}$	$61\frac{1}{4}$	
,,	,,	,,	,,	15	1 ,, 10	65	7·28	9	$58\frac{1}{2}$	$8\frac{1}{4}$	$61\frac{1}{4}$	
,,	,,	,,	,,	16	8 ,, 75	65	7·28	9	$58\frac{1}{2}$	$8\frac{1}{4}$	$61\frac{1}{4}$	D. $61\frac{1}{4}$
,,	,,	,,	,,	18	3 ,, 25	65	7·28	9	$58\frac{1}{2}$	$8\frac{1}{4}$	$61\frac{1}{4}$	W. $8\frac{1}{4}$ grs.
,,	,,	,,	,,	20	2 ,, 15	65	7·28	9	$58\frac{1}{2}$	$8\frac{1}{4}$	$61\frac{1}{4}$	
18,440	304	$5^{1}/_{15}$	76 *v.* = 15″	16	2 ,, 19	65	7·10	9	$57\frac{2}{3}$	$8\frac{1}{4}$	$60\frac{2}{3}$	
18,360	306	$5^{1}/_{10}$	51 *v.* = 10″	18	2 ,, 17	65	7·00	9	$57\frac{1}{3}$	8	$60\frac{3}{4}$	
18,600	310	$5^{1}/_{6}$	31 *v.* = 6″	15	3 ,, 31	65	6·83	9	$56\frac{2}{3}$	8	60	
18,720	312	$5^{1}/_{5}$	26 *v.* = 5″	18	3 ,, 26	65	6·73	9	$56\frac{1}{4}$	8	$59\frac{2}{3}$	
19,200	320	$5^{1}/_{3}$	16 *v.* = 3″	15	3 ,, 32	65	6·40	9	$54\frac{3}{4}$	8	$58\frac{1}{4}$	
,,	,,	,,	,,	16	1 ,, 10	65	6·40	9	$54\frac{3}{4}$	8	$58\frac{1}{4}$	
,,	,,	,,	,,	20	1 ,, 8	65	6·40	9	$54\frac{3}{4}$	8	$58\frac{1}{4}$	
19,440	324	$5^{2}/_{5}$	27 *v.* = 5″	18	1 ,, 9	65	6·23	9	$54\frac{1}{4}$	8	$57\frac{1}{2}$	
19,680	328	$5^{7}/_{15}$	82 *v.* = 15″	16	4 ,, 41	65	6·10	9	$53\frac{1}{2}$	$7\frac{3}{4}$	$56\frac{2}{3}$	
20,400	340	$5^{2}/_{3}$	17 *v.* = 3″	17	1 ,, 10	65	5·67	9	$51\frac{2}{3}$	$7\frac{1}{2}$	$56\frac{1}{2}$	
,,	,,	,,	,,	20	4 ,, 34	65	5·67	9	$51\frac{2}{3}$	$7\frac{1}{2}$	$56\frac{1}{2}$	
21,000	350	$5^{5}/_{6}$	35 *v.* = 6″	20	4 ,, 35	65	5·36	9	$50\frac{1}{4}$	$7\frac{1}{2}$	55	D. 55
21,600	360	6	6 *v.* = 1″	18	1 ,, 10	65	5·06	9	$48\frac{3}{4}$	$7\frac{1}{4}$	$54\frac{1}{3}$	W. $7\frac{1}{2}$ grs.
				20	1 ,, 9							
22,800	380	$6^{1}/_{3}$	19 *v.* = 3″	20	2 ,, 19	65	4·55	9	$46\frac{1}{2}$	7	$52\frac{1}{2}$	
24,000	400	$6^{2}/_{3}$	20 *v.* = 3″	20	1 ,, 10	65	4·10	9	44	$6\frac{3}{4}$	$50\frac{2}{3}$	

*The weight in the column where both are variable approximates to a mean of the weights in the two former columns, and the suitable diameter is obtained by calculation. The arc of vibration is constant, viz. one turn and a half.

†Earnshaw's well-known train for his marine chronometers, and which Foreign Observers call the Chronometer Vernier, and use it as a medium of comparison for all other chronometers.

ratio of the square of the diameter, the square of the number of vibrations per minute, or the square of the number of degrees in the arc of vibration.

The most useful trains are :—

For lever escapements, a velocity of 270, 280, and 288 per minute.
For marine chronometers, 240, the well-known half-second beat.
For duplex, 300 per minute.
For pocket chronometers, 300 to 320. The latter is the celebrated Arnold train for his pocket chronometers.

On page 163 we find a letter entitled *Mr. Cole in reply to Mr. Frodsham.* In this Cole says :—

That, after requesting my name to be withdrawn from Mr. Frodsham's paper, he should have thought it either just towards me, or judicious on his own part, to subject his sincerity as a friend, or his early competency as a watchmaker, to being questioned or touched on, somewhat surprises me, knowing as I do his extreme sensitiveness on both those points.

Charles Frodsham's final article in this series is to be found on page 19 of the October, 1860, issue of the *Journal.* He emphasises that the bad shape of the great wheel teeth is more detrimental than in the pinion, saying that as much as ten per cent of the power may be wasted from this cause. A good watch should never have a pinion of less than 12, that being the lowest number that commences to drive behind the line of centres. He complains that the Lancashire wheel-cutters tend to fall into the old habit of cutting the teeth the shape of a pear, instead of that of a willow leaf. Power is only created by using a stronger mainspring. Power is easily wasted by badly shaped teeth and pinions, and by too much drop. Finally he says that the actual weight of the wheel work is of little importance.

William Johnson, 50 The Strand Late " Grimalde & Johnson "

In 1861, William Johnson died and Charles was able to acquire the business from the son, of the same name. Johnson had been a chronometer maker, especially of the pocket variety. He had been

taken into partnership by Peter Grimalde in 1810. Peter Grimalde, who had commenced business at No. 431 The Strand in 1801, died in 1812 and the business was then carried on by William Johnson and Mrs. Eleanor Grimalde (Peter's widow) until her death in 1829. Although in 1829 the property was bought by the Office of Woods & Forests, William Johnson was able to re-open the business at 50 The Strand, but this time in his own name. No. 50 The Strand was almost opposite to 431 The Strand.

Charles Frodsham put his son, Charles Mill Frodsham, aged 25, in charge of this business for that year only, and after this the business was transferred to No. 84 The Strand.

Agents

At about this time Charles' agents in America were Messrs. S. Willard & Son, well-known clockmakers in Boston. He also had agents at Nantes (the great French ship-building centre) and at Santander on the north coast of Spain.

Clockmakers' Company

Charles Frodsham had been made a Freeman of the Company in 1845 and in due course he became Master in 1855 and again in 1862. He was one of the original members of the British Horological Institute and was elected Vice-President in 1862. He donated freely to the funds of the Institute.

Turret Clocks

The firm supplied a number of turret clocks, as for example the small striking clock at Blue Mills, Witham, Essex, which is stamped " Chas. Frodsham Strand London ". **Plate 57**, page 400.

The Great International Exhibition, 1862, South Kensington

Charles Frodsham was one of the Jurors for this exhibition and was awarded a Medal of Honour for his services.

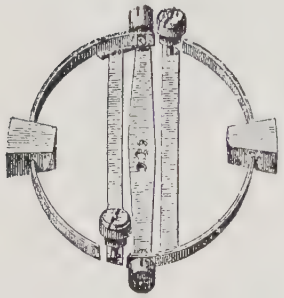
Besides exhibiting pocket chronometers, chronometer repeaters, stop split-seconds and other timing and stop watches, he showed examples of his new calibre lever watches. He also exhibited :—

A month marine chronometer.

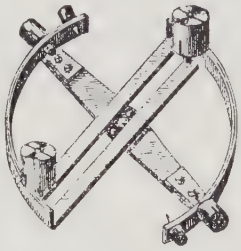
A model church and turret clock, constructed after designs proposed for the clock of astronomical accuracy for the New Houses of Parliament.

New " Duo in Uno " balance springs.

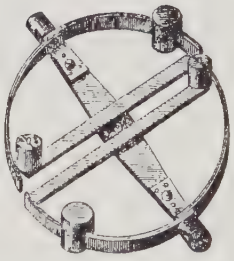
Three new balances, derived from the combined balance he had shown in 1851.



Double compound Micrometric Equation balance, invented and made by C. Frodsham.



Compound double inverted Differential balance, invented and made by C. Frodsham.



Compound triple Equation balance, invented and made by C. Frodsham.

The first of these balances, " The double compound Micrometric Equation balance ", was to form the basic principle for the later " Frodsham balance " which was employed in his finest marine chronometers and carriage clocks. **Plates 62 and 63**, page 406.

Charles reported on this exhibition at some length. Besides describing the exhibits he took the opportunity to dissertate on a variety of subjects concerning clockwork. There is even a table to show the mean daily rates of his marine chronometer No. 3148, with simple brass balance, which was not on show at the exhibition.

The various compensation balances to be seen on display are well described, but he then gives the reader a lecture on *Acceleration of Rate.*

Astronomical Clock Escapements are of interest. Dr. Clark, an amateur, showed a variety of gravity escapement which is described in detail, but once again Charles cannot resist the temptation to discourse on *Dead-Beat Escapements* for the next five pages (out of a total of 21 pages).

Page 13 is devoted to a chart showing the sizes of the *Principal Parts of the Lever Escapement.* Then we have a description of the types of watches shown in the exhibition which covers a number of

pages, one of which is devoted to *A Table of the Corresponding Sizes of English Watches.*

One outstanding exhibit was a set of models illustrating the action of the spiral spring. This was submitted by Monsieur Phillips who had written a book on the subject, *Mémoire sur le Spiral Réglant des Chronomètres et des Montres.* His colleague M. Laurier attended the exhibition each morning and delivered a lecture on these models.

Breguet's exhibits were very much appreciated, but let me quote Charles' words in describing a **Breguet tourbillon** which carried the balance round once in a minute. " This escapement is, without exception, one of the most ingenious horological inventions that I know; and although no longer in use, except among amateurs, almost every exhibitor of repute in the Swiss department had revived it and exhibited excellent copies ". Charles enlarges on this when describing the Swiss section :—

> The reproduction of this escapement, which was first brought out by Breguet in 1808, and whose use science had rendered no longer necessary, appeared to us a rather remarkable and unaccountable fact. This constitutes one of the great differences between the best watchmakers in Switzerland and those in England. The former display their talent in works of difficult combination; and it adds much to their credit to have selected that beautiful specimen of horological ingenuity; for, I am sure, that whilst watchmaking lasts, this escapement will find a place in the cabinet of the connoisseur. In England, however, we are called upon to display our abilities in the positive results of good time-keeping; to make chronometers for all the maritime nations of the globe; and to have our talents estimated by the test of within what fraction of a second our chronometers shall maintain their daily rates during long voyages, although exposed to every variety of temperature and motion.

This line of thought could explain why it took over thirty years before the manufacturers in England began to make tourbillons.

" A Few Facts Connected with the Elements of Watch and Clock Making "

This was published in 1862 as a 41-page booklet. Charles calls it " a lecture " but there is no record of its having been delivered. The purpose of this lecture was to suggest a new standard of measurement for watches, but first he described certain measuring devices.

The Vernier Slide Gauge

This can be used to estimate correctly any space to be measured to the thousandth of an inch or to the third decimal figure. When the chops are closed the zeros should perfectly agree both on the stock and the vernier, if they do not there is an index error due to slight wear of the chops. Note this error and add it to all readings.

The Universal Adjusting Rod, or Steelyard

He showed how this instrument can be used, whilst adjusting the mainspring, to read off its force in Troy ounces. One can also predict the required force of every mainspring by the mere cubic capacity of the barrel.

The Duo-in-Uno Balance Spring

This is praised on page 22, where he says that it ensures " almost certainly correct performance in all the various positions with a perfectly poised balance ".

This type of balance spring is said to have been invented by Mr. Mairet, of Baker Street, and was shown by Charles and Mr. Maclennan in the 1862 Exhibition, but had been used by Arthur Paul Walsh since about 1860.

The Slide Rule

He explains in detail its use in horology, and was praised for pointing out its uses by T. Hewitt in the *Horological Journal* for March, 1889, page 101.

The Lancashire Gauge

In the booklet Charles explains that he had some difficulty in understanding the meaning of this gauge which was used to obtain

the sizes of movements. His explanation is by no means easy to understand. See **Appendix XVI**, page 319.

In effect he tells us that the size of the :
Pillar plate is obtained by calling a plate 1 inch in diameter, size 0, each size increasing by 1/30th of an inch so that we have :

Size 0 = 1 inch diameter
1 = 1 + 1/30 inch
2 = 1 + 2/30 inch and so on.

(As we shall see these sizes are identical with the Lancashire watch glass gauge sizes.)

Dial plate is obtained by adding 5/30 of an inch to each of the above sizes. This is the so-called **" Lancashire Movement gauge "**, so that we have :

Size 1 = 1 + 1/30 + 5/30, i.e., 1 + 1/5 inch
2 = 1 + 2/30 + 5/30 inch
16 = 1 + 16/30 + 5/30 inch and so on.

The 5/30 of an inch, he explains, is to allow for the " fall ", that is, for room to allow the works to open and shut in the case. **Plate 32**, page 374.

In the early verge watches, which were quite thick, the movement was built up from the pillar plate, and then an extra plate, the dial plate, was added, being placed in front of the pillar plate. The dial plate had to be much larger than the pillar plate to allow for the " fall ". But as watches became thinner, less fall was required and so the extra plate, i.e., the dial plate, was no longer necessary, and one plate, i.e., the pillar plate, was made slightly wider to enable it to take the dial.

The Lancashire Pillar Gauge **Plate 33**, page 375

This gauge is for measuring the heights of pillars.

Each graduation in height is equal to 1/144th part of an inch. Sizes commence at 0/6 which is equal to 1/12 inch.

0/5 = 1/12 + 1/144 inch
0 = 1/12 + 6/144 inch = 1/8 inch
30/0 = 1/8 + 30/144 inch = 4/12 inch
(not 3/12 as stated by Charles)

Frodsham Movement Gauge

Charles suggested that it would be much simpler to use the decimal parts of an inch instead of 1/30th or 1/144th (for the pillar gauge).

He took his measurements from the all-in-one pillar plate (which, as explained, no longer had an extra dial plate attached to it, so that the all-in-one pillar plate was about the same diameter as the dial itself) and gave his sizes in numbers which were directly related to the actual measurement, thus :

a 1 inch diameter pillar plate became size 10
1½ ,, ,, ,, ,, ,, ,, 15
2 ,, ,, ,, ,, ,, ,, 20

Frodsham Pillar Gauge

Here the graduation is in 1/100 inch.

Starting with 10/100 inch which he called size 10 or .1 inch
Leading to 12/100 inch ,, ,, ,, ,, 12 or .12 inch
,, ,, 12.5/100 inch ,, ,, ,, ,, 12½ or .125 inch

Unfortunately the Frodsham gauges did not appeal to the manufacturers who were perfectly happy to continue to use the old Lancashire method, and so Charles' suggestion was never adopted. Nearly all the manufacturers probably considered that to change the sizes would only create confusion, but one manufacturer did agree that the old method was not good enough, and only four years after Charles' pronouncement, John Wycherley introduced his own method of gauging sizes.

John Wycherley

Born in 1817, he became a famous manufacturer of watch movements at Prescot in Lancashire. He had been apprenticed to Messrs. Hewitt, manufacturers of watch and chronometer movements, and

continued to work for the firm until about 1850, when he acquired the business of a balance manufacturer by the name of Edmond Range who had died, leaving a widow. John Wycherley married Edmond Range's widow and proceeded to develop the business to include the manufacture of watch movements. It must be remembered that at that time movements were made by hand, so that much time was wasted in measuring, etc.

In 1866 he built a large three-storied building in Warrington Road, Prescot, setting it up as a factory for the manufacture of watch movements, and he decided, in spite of great opposition, to adopt his own " J.W." system having only eight sizes of watches, each size differing by 7/100ths of an inch. He designed and made the necessary machine tools, which were accurate to within 1/100th of an inch, so that cases, caps and dials could also be standardised. (*Horological Journal*, October, 1891, page 17.)

One great advantage was that the pillar had its size clearly marked on the dial side of the plate, and the train wheels and pinions were all accurately pitched, so that uniformity was ensured, thereby saving considerable time in the finishing.

The J.W. pillar plate diameter sizes were as follows :

Size	Inches	Size	Inches
4	1.34	12	1.62
6	1.41	14	1.69
8	1.48	16	1.76
10	1.55	18	1.83

Nevertheless, it is perhaps to be regretted that Wycherley did not follow Frodsham's suggestion of using a numbering directly related to size. If one examines the chart showing comparative sizes one can see how easily Wycherley could have done this.

Watch movement pillar plate sizes and diameters, including dial plate if fitted

Lancashire 1 = 1/30 inch		Wycherley 2 = 7/100 inch		French Ligne 1 = .0888 inch		Frodsham 1 = 1/10 inch	
Size	Inches	Size	Inches	Size	Inches	Size	Inches
1	1.2			*13½*	1.2	*12*	1.2
2	1.233			*14*	1.243	*12½*	1.25
3	1.266						
4	1.3					*13*	1.3
5	1.333	*4*	1.34	*15*	1.332		
						13½	1.35
6	1.366						
7	1.4	*6*	1.41			*14*	1.4
				16	1.421		
8	1.433						
						14½	1.45
9	1.466						
		8	1.48				
10	1.5			*17*	1.510	*15*	1.5
11	1.533						
		10	1.55			*15½*	1.55
12	1.566						
13	1.6			*18*	1.598	*16*	1.6
		12	1.62				
14	1.633						
						16½	1.65
15	1.666						
				19	1.687		
16	1.7	*14*	1.69			*17*	1.7
17	1.733						
						17½	1.75
18	1.766	*16*	1.76				
				20	1.776		
19	1.8					*18*	1.8
20	1.833	*18*	1.83				
						18½	1.85
21	1.866			*21*	1.865		
22	1.9					*19*	1.9
23	1.933						
				22	1.954	*19½*	1.95

Watch Glass Sizes

So far we have only discussed movement sizes. In his booklet Charles does not mention the sizes of watch glasses, an omission which it is now proposed to try to fill.

English Watch Glass Gauge

Some form of gauge must have been used by watchmakers for the past two hundred years or more. The principle of the English watch glass gauge is quite simple when one understands it. All the watchmaker has to do is to measure the diameter of the aperture for the glass, without taking into account the slot, 1/60th of an inch in depth, into which the glass has to fit. The glass will therefore require to be 1/30th of an inch wider in diameter than the actual aperture.

The English gauge commences at size 0 which measures 1 inch plus 1/30th of an inch, and each size is 1/30th of an inch larger than the last, so that size 10 measures 1 11/30th of an inch. Now supposing the diameter of the aperture for the glass to measure 1 10/30th of an inch, then all the watchmaker has to do is to order size 10 and he will be supplied with a glass measuring 1 11/30th of an inch in diameter.

There were three types of gauge available for the purpose of measuring the size of a watch glass, when measured on the **English** scale.

1. A straight piece of box-wood measuring $4\frac{1}{4}$ inches long by $\frac{5}{8}$th inch wide having a slightly raised brass ridge at about $1\frac{1}{4}$ inches from one end. This brass bar acts as the base against which the watch glass rests. A scale commences at a distance of 1 1/30th of an inch from this bar. The scale is $1\frac{1}{2}$ inches long and is divided into 30ths and 60ths of an inch. Each 30th equals one size. **Plate 33**, page 375.

2. A fixed sector. A " V "-shaped groove, having a vertical scale divided into fifths of an inch (which = 1 size), each size being subdivided into four, so that the sizes read, 0, $0\frac{1}{4}$, 0 2/4, $0\frac{3}{4}$, 1, $1\frac{1}{4}$, etc., up to 35. Size 35 would be for a glass 2.332 inches in diameter. **Plates 35 and 36**, pages 377 - 378.

3. A slide gauge, divided into 30ths of an inch, commencing at a distance of 1 1/30th of an inch from the base.

Watch Glasses

Watch glasses can be found with a variety of labels stuck on to them.

Some have only one number :

Some have two numbers :

Some have three numbers :

Some have four numbers :

In order to understand these numbers it must be explained that there are four scales for measuring the **diameter** of watch glasses, as well as a scale for measuring the **height** of the glasses.

The Diameter of Watch Glasses

The "**Comparative Table**" to be seen in **Appendix XIX**, pages 327 - 333 compares the four methods of measurement. Let us call these four methods **m/m**, **A**, **B** and **C**.

m/m The diameter is measured in tenths of a millimetre. It commences at 158 and continues up to 521.

A. This is an ascending scale in which the sizes increase by 1/16th per size, commencing at 7 and continuing up to 23 2/16ths.

The measurement in this case is in **lines** (lignes).
1 line = 2.25mm. = 0.0888 inch or 89/1000 inch approximately.
7 lines = 158 tenths of a millimetre approximately.

Plate 34, page 376

B. This is an entirely different scale in which the sizes **differ** by 1/8th per size.

The smallest size is 7/0, the next 7/0 1/8, and then 7/0 2/8 and so on to 7/0 7/8, and then we have 6/0, 6/0 1/8, 6/0 2/8, and so on, and so on until it reaches 2/0 7/8, and the next size is 0, and then 0 1/8, 0 2/8, etc., etc., ascending by 1/8 per size, up to 26 2/8.

Readers may be puzzled, as I was, by the apparently curious jump in the scale from 2/0 7/8 to 0. Eric Street has solved the problem and explains that it has to be appreciated that the numeral preceding each stroke in front of 0 is only a way of denoting the number of 0's; 3/0 is really 000 and 2/0 is 00. So, if the next size after 3/0 7/8 is 2/0, then the size to follow 2/0 7/8 is 1/0, which is, of course, a single 0. The 1/ is unnecessary.

This scale is also related to the **line** measurement.
Each **full size** corresponds to **half a line**, and size 0 = 10 lines. So we have :—

7/0 = 7	lines	2 = 11	lines
5/0 = 8	,,	4 = 12	,,
3/0 = 9	,,	8 = 14	,,
2/0 = 9.5	,,	16 = 18	,,
0 = 10	,,	22 = 21	,,
1 = 10.5	,,	26 = 23	,,

C. A scale in which the sizes **differ** by 1/4 per size.
The smallest size is 12/0, the next 12/0 1/4, 12/0 1/2,

12/0 3/4, then 11/0, 11/0 1/4, 11/0 1/2, and so on to, 2/0 1/2, 2/0 3/4, 0, 0 1/4, 0 1/2, 0 3/4, 1, 1 1/4, and so on up to 29 3/4.

This group is known as the **Lancashire** or **English Watch Glass** sizes. Each full size differs by 1/30th of an inch.

Size	0	=	1		1/30	inch,	or,	1.033	inch,	or,	264	tenths m/m.
,,	1	=	1		2/30	,,	,,	1.066	,,	,,	271	,, ,,
,,	2	=	1		3/30	,,	,,	1.099	,,	,,	279	,, ,,
,,	3	=	1		4/30	,,	,,	1.133	,,	,,	287	,, ,,
,,	4	=	1		5/30	,,	,,	1.166	,,	,,	296	,, ,,
,,	5	=	1		6/30	,,	,,	1.200	,,	,,	305	,, ,,
,,	9	=	1	10/30		,,	,,	1.333	,,	,,	339	,, ,,
,,	19	=	1	20/30		,,	,,	1.666	,,	,,	426	,, ,,

Watch glasses having only one number

The number refers to Group A, especially if measured in 1/16ths.

The number refers to Group C, especially if measured in 1/4ths.

(If the number is a simple one and has no fraction it is not obvious to which group the number refers.)

Watch glasses having two numbers

These numbers refer to Groups B and A, especially if in 1/8ths and 1/16ths. But sometimes to either Group A or Group B, plus a number giving the height.

Watch glasses having three numbers

Refer either to Group A plus B plus a number giving the height, or to m/m plus A plus B.

Watch glasses having four numbers

The top number is the size in tenths of a millimetre.

Then A, B and the height.

The Line Pillar Gauge **Plate 33**, page 375

Eight gradations in height are equivalent to 1 line in height :

Size 1 = 14/16 of a line		
2 = 1 line		i.e., 2.25mm.
10 = 2 ,,		4.50mm.
18 = 3 ,,		6.75mm.
26 = 4 ,,		9.00mm.
30 = 4½ ,,		10.12mm.

Tables

Charles Frodsham liked to have as much information as possible in the form of tables; in this way he saved himself much time in working out problems, by a glance at the appropriate table.

This booklet, i.e., "A Few Facts, etc.", has a number of these tables, for example :

The Corresponding Sizes of English Watches.
Corresponding Measurements. Inches — Metres — Lignes.
Comparative Strength of Mainsprings.
Comparative Strength of Mainsprings by a Poised Rod.
Lengths of Pendulums in London.
Dilatation of Different Substances by Heat.
Specific Gravities. Fusing Points. Solders. Boiling Points.

In 1853, Charles had already published the following useful tables :

"A Set of Five Tables for Fascillitating the Operation of Timing Watches and Chronometers" :

Table G. No. I.	For Gaining Watches.
Table G. No. II.	For Losing Watches.
Table G. No. III.	For Circular Compensation Weights.
Table G. No. IV.	Shows the Available Regulating Power of the Two Mean-time Screws of a Compensation Balance.
Table G. No. V.	Comparative Powers of Balance Springs.

"A Table Showing the Diameter and Weight of Balance Suited to Different Kinds of Watches and Chronometers." **Appendix XVII**.

The fact that Charles Frodsham took the trouble to work out all these tables indicates that he must have been remarkably thorough and methodical in his methods. It will be seen that he paid great attention to such matters as properly proportioned trains which he considered to be essential for accurate timekeeping. See **Appendix XVII**, pages 322 - 324.

Mercurial Compensation Pendulums

In 1866, Charles Frodsham published an eight-page booklet entitled " Mercurial Compensation Pendulums, their Construction and Adjustments ". He explains that although the pendulums he had been using, with steel rod and light steel jar, had been very satisfactory, yet they were liable to the effects of magnetism and rust, and were expensive due to the labour involved in working steel. He therefore tried using pendulums having a tubular brass rod and the mercury in glass tubes. **Plate 37**, page 379. The one illustrated has two glass tubes, but he had tried using from one to four tubes. The advantages he claimed were :—

1. The more perfect conducting powers of brass over steel [presumably of heat].
2. The freedom from magnetism and rust.
3. The superior lightness of the rod, its strength, its cheapness and the ease of construction.

As regards the adjustment of these pendulums he said :

The simple mode of using guides for two or more compensation tubes will enable a person to change his simple pendulum into a compound one with the utmost facility, for he has only to remove the bob and slip the guides over the rod, when, if it be of iron or steel, he will require a column of $6\frac{4}{10}$ inches of mercury; or if it be a brass rod or tube, one of $11\frac{3}{10}$, and his pendulum will approach very nearly to perfect compensation—the correction in either case, for an error of one second per day for 60° of temperature for a steel rod, is to remove or add $\frac{1}{17}$ of the whole weight of mercury, or for brass $\frac{1}{28}$ from each of the compensating tubes

employed. No fear need be entertained about the difficulty of bringing the pendulum to time again, because the value in time of one turn of the regulating nut is so easily ascertained. The plan I adopt is to have an ivory rule divided to hundredths of an inch, and then fairly measure upon the pendulum the quantity I require to alter it. I am accustomed to engrave two lines on the tube, with the letters S.T. and M.T., to denote the difference in the lengths of sidereal and mean time pendulums, which is 0.217 inches.

One of the most ready modes of regulating a clock that is very wide from time, with the smallest number of attempts, is, to ascertain its error in time per minute, and then find, by a simple calculation, the corresponding fractional part of an inch by which it requires to be shortened or lengthened to correct it.

For example, let us suppose the pendulum to be one of the ordinary second's length, which from the shoulder of the spring to the bottom of the jar is 39.14 inches + half the length or height of the jar, and that its error per minute, observed by a good chronometer, is $\pm \frac{1}{2}$ a second, which is $= \frac{1}{120}$ of a minute. Then, without having the trouble of squaring the time and performing a long calculation, you have only to double the fractional error in time to obtain the fractional correction in parts of an inch.

Example, of $\frac{1}{120}$ min. $\times$ 2 $= \frac{2}{120} = \frac{1}{60}$ and the pendulum's true second's length to the centre of oscillation $\frac{39.14}{60} = 0.65$ parts of an inch which is the quantity the pendulum must be shortened or lengthened to correct the observed error.

Another example. Let us take the well-known difference between a mean time and a sidereal time second's pendulum = 9″.856 per hour, which for brevity we will call 10 seconds. Now, $\frac{10}{3600} = \frac{1}{360}$ and $\frac{1}{360} \times 2 = \frac{2}{360} = \frac{1}{180}$. Then $\frac{39.14}{180} = \pm$ 0.217 parts of an inch.

These ratios are very useful and universal in their application: the length of the half-second's pendulum to the c. o. = 9.8 inches, and $\frac{9.8}{180} = \pm$ .0544 parts of an inch, the correction for reducing a half-second's pendulum from a mean to a sidereal time, or the contrary.

In this rule we have nothing to do with the visual or actual mechanical length of the pendulum, as that varies with the shape and length of the bob. In mercurial pendulums, half the height of the jar added to the length of the pendulum to the centre of oscillation is very near the truth, viz., 4.25 + 39.14 = 43.39. And in the new brass second's pendulum, half the height of the guides and tubes is about 6 inches, which, added as before to 39.14 = 45.14, the average length these pendulums measure from the shoulder of the suspension spring to the bottom of the jar, when at mean time.

The above simple rule for regulating a clock is only correct within certain limits, and is not accurate beyond an error of 2″ per minute or 2 minutes per hour, which, however, is a wide margin. $\frac{1}{30} \times 2 = \frac{2}{30} = \frac{1}{15}$ and $\frac{39.14}{15} = \pm 2.61$ the correction. Now, let us compare this with the rule, that the lengths of pendulums are as the squares of the times, that is $39.14 \times \frac{58 \times 58}{60 \times 60} = 36.57$, and $39.14 - 36.57 = 2.57$ instead of 2.64 inches. From this point the rule becomes more wide of the truth, and recourse must be had to the legitimate rule as above. That the length of pendulums are as the squares of the times of their vibrations, or that the times are as the square roots of their lengths. For small errors per diem, a simple proportion is sufficient, $\frac{9}{10,000}$ of an inch affects a seconds pendulum a second per diem.

The mercurial, although decidedly the best of all compensation pendulums, is very restricted in its use when made with a steel rod, and is not well suited for those that are longer than the one second's length, because in the $1\frac{1}{4}$ and $1\frac{1}{2}$ seconds' lengths the compensation is too far removed from the mean length of the rod, and in short pendulums, say of $\frac{1}{2}$ second, the column of mercury is so much reduced in height, that it leaves the pendulum almost without the necessary weight and momentum; by employing brass rods or tubes, however, all the lengths from one to half a second are suitable.

The brass construction is particularly well suited for heavy pendulums: for example, a brass tube with a single central tube

of mercury, held in glass, 11.5* inches high and only 2½ diameter, will weigh about 25 lbs., which, with an additional 5 lbs. for the bob and rod, would make a pendulum heavy enough for any astronomical clock, and the weight of the mercury would be five times heavier than the rod and jar.

I consider the relative weight of the mounting to that of the mercurial compensating medium, to be an enquiry of no small importance, particularly in sudden small changes of temperature; but the most important feature in every pendulum is the direct and uniform expansion and contraction of the rod by heat and cold. Many rods that have not been well annealed curve into a bow, instead of remaining perfectly straight throughout the thermometric range, and give rise to all sorts of conjectures, as to the errors produced, except, probably, the right one. I have by me a specimen of such a rod, being one which gave me a great amount of trouble, before I discovered the source of the clock's error.

It is a singular circumstance, that during my recent pendulum experiments, I found some of my predecessor's papers dated 1775, relative to his researches concerning the uniform expansion of brass, steel and zinc rods. Zinc was the favourite compensation of the first Arnold, and all his compensation pendulums were of that character. The mode of slipping on the guides containing the mercurial tubes, will be readily understood by a glance at the diagrams. One represents the second's pendulum, and is jointed telescopically, on account of the difficulty of making a perfect tube of 45 inches in length; but even if it offered no difficulty on this account, I have preferred the pendulum in two short lengths, as more likely to be free from curvature, which leaves us only the direct expansion and contraction by changes of temperature to contend with.

*With my new pendulum oven just finished, I shall determine these points more accurately.

Honours and Awards

Besides those already mentioned, Charles received the following awards :

1860 **Gold medal, Praemia Digno**, from the **Emperor of Russia**, " For services rendered to the Great Russian Survey ".

1865 Juror at the **Dublin Exhibition.**

1867 **Grand Medal of Honour** as English Juror at the **Grand International Exhibition at Paris.** He was also Vice-President of the exhibition.

International Exhibition, Paris, 1867

In the 1862 Exhibition the number of horological exhibitors was 300, of whom, the United Kingdom had 97, Switzerland 72, and France 54.

In the 1867 Exhibition there were 535 exhibitors of whom the United Kingdom had 29, Switzerland 163, and France 223.

This difference can, of course, be accounted for by the fact that the 1862 Exhibition was held at South Kensington, London, whilst the 1867 one was at Paris.

C. R. Weld was the reporter for this exhibition*, and he seems to have had a partiality for Charles Frodsham's ideas, such as :

a. The brass tubular compensation pendulum with the mercury held in hermetically sealed glass tubes. This had a galvanic apparatus for recording the time of observations. This clock was made for the Cambridge Observatory, U.S.A., and is similar to the one made for the Melbourne Observatory.

b. The micrometric balance which affords a very simple means of adjustment without removing the balance from the chronometer or disturbing its mean time.

c. A dead-beat clock escapement having an escape-wheel $2\frac{1}{4}$ inches in diameter and the pallets embracing 9 teeth or $8\frac{1}{2}$ spaces.

The report is full of interesting facts concerning the manufacture of watches in France and Switzerland, and also concerning Lancashire. It said that in the census of 1861, 23,427 persons were engaged in the watch trade in England, the greater portion of whom resided in Lancashire.

**Reports on the Paris Exhibition*, pages 543 - 561.

Galvanic Apparatus

On the 18th of August, 1868, Charles wrote to Airy :

> It has occured to me that if a similar Galvanic Apparatus were applied to an uncompensated Marine Chronometer as is applied to the Royal Observatory Clock in connection with the Chronograph, the minutest changes of temperature might be accurately noted either at 1, 2, 3, 5, 10 or otherwise, such as has not yet been measured. What value it might be in meteorological science I leave in your able hands.
>
> I may mention that the application of the Galvanic Apparatus to Marine Chronometers answers equally as well as to the Clocks, that is when we break contact, but to make contact will be considerably more labour for the Chronometer to do. The latter I have not yet tried.
>
> Those I have constructed record every second — once in two seconds — once in three seconds — and once in five seconds, as occasion required.
>
> Begging the favor of your opinion as to its probable utility and apologizing for troubling you.

Airy replied to the effect that such an apparatus could be very useful particularly in defining the law of temperature-error of chronometers. Charles wrote again to Airy on the 30th September, 1868 :

> I have the honor to thank you for your esteemed favor of the 16th instant. Since my last I have succeeded equally well in making the Chronometers **make** and **break** contact.
>
> My object in these constructions have been various. First to an order from the United States Observatories, as adjunct to their great surveys and other Observatory work.
>
> I think an **uncompensated** Chronometer in connection with one **compensated** by the means of an accurate Chronograph may lead to the discovery of when and how the variation of rates in both Chronometer and clock occur, for during short intervals in the day, say 3 hours trial, we seldom detect an indication of a

variation of its uniformity. It is a well known fact that Chronometers and Standard Clocks sympathize with each other to a remarkable degree. Seeing they derive their times of vibration from such different principles we may perhaps here get some new light thrown upon the subject.

The letter then describes how the apparatus could be used to detect the cause of errors, due to a change of temperature, in mercurial pendulums, and Charles suggests that experiments could best be undertaken in an Observatory. The letter continues :

At present the make contacts record every second, omitting the 60; those made for the United States break contact and record every two seconds, the minute being marked by the record 59 - 60 sec. or 60 - 61 sec. as required; but for the **Chronometrical thermometer** once a minute might be sufficient.

Chronometers with Galvanic attached might be made Motor Chronometers and discharge signals and do all the work Motor Clocks do with the advantage of portability.

The letter is somewhat lengthy but the above extracts give some idea of Charles' thoughts. However, on December 9th, Airy replied to say that at present he could not arrange any such galvanic experiments and that, " Our hands personally, and my own in particular, are very full at present, and I have very little freedom of mind for such purposes ".

Large Impulse Roller

The first mention of the idea of trying the use of a large impulse roller is to be found in a letter written by Airy to Charles on August 24th, 1866, in which he said :

Concerning the rate of chronometers which have come before me for some time past, there is one thing which has surprised me and that is the decided difference of practical skill among chronometer makers.

Latterly we had a few makers who made a few good chronometers and all the rest were very indifferent. Now we have a

great number of makers who furnish a great number of excellent chronometers.

All of the first rate chronometers continue to rise in excellence and second rate chronometers rise much more rapidly.

Now this seems to me to prove not that the principles of chronometry are better than they were, but that the mechanical skill in the workshop is better than it was. And as long as the present construction is maintained, the tradition of the trade will maintain chronometers in high excellence for many years. And not with any special design improvement.

Now I should be glad to have an effort made affecting the principle.

There is one point, almost of the nature of a principle, which has occured to me, and which I submit for your consideration.

The blow of the escape wheel upon the chronometer balance pallet is very heavy for so light an instrument. This blow is felt as pressing the staff pivots sideways in their holes; and any irregularity in form of pivots or form of holes, state of oil, produces an irregularity of rate proportional to that pressure.

And the reason why that pressure is heavy is that it is given so near to the centre of motion.

It seems to me therefore that the direction in which we ought to look first for improvement of chronometers is, to give the impulse at a greater distance from the balance staff.

All which, as I have said, I submit entirely to your judgement. But I should be glad to have your remarks on it.

Charles obviously had a great respect for any suggestion put forward by Airy and this new idea caused him to ponder carefully before replying. Eventually on October 11th, 1866, he wrote to Airy. His carefully worded letter covers four pages of foolscap :

In reply to your interesting letter of the 24th August I consider that the effects you refer to are partly due to the schoolmaster being abroad; partly to the continuance of the trials and publication of the going of Chronometers at Greenwich; and also to the

Great Exhibition of 1851, which is now and for some time past has been showing its good fruits.

The peculiarities of any eminent maker are now more carefully studied than formerly; and men have learned that the finest principles may be destroyed by the neglect of the minutiae : attention to the minutiae was one of the points of my father's success. Certain well qualified persons were charged with the examination of the separate pieces of the work before any attempt at adjustment was made; such as the sizing of wheels and pinions; correct gearing; play in the holes etc.. Another examined the proper shape of the holes; the filing up of the teeth of the escape wheel; finishing off the points so that they should not scratch the nail, but act like burnishers. Then that important piece, the locking spring, was weakened to a proper strength, set on sufficiently and then fixed by heat. The discharging spring was also carefully weakened, and that most important point attended to, secure locking with easy unlocking : for this purpose the locking stone, made of ruby, has to be set at a slight angle for the draw; also to stand out of the wheel, as well as to stand back, so that the bottom part of the escape wheel only presses upon the stones, not standing with its edge parallel to the wheel, but leaning out so as to prevent the spring from twisting during the progress of the balance unlocking the escapement.

These locking stones were wonderfully improved under my father's care and so delicate a point is this in the scapement, that the neglect of it will destroy the daily rate of the best chronometer.

Now with regard to drop, that was another point which we reduced to minimum. We are obliged to have a small drop in order to free both the escape wheel and the edge of the impulse roller, and also to free the locking stone from the back of the escape wheel tooth; and I do confess that this drop by a ratchet tooth on one side of the vibration is a disagreeable jar, and to this we attribute the flirting away of the oil from the pivots of the balance axis, which is one of the difficulties we had to contend with, for out of 50 Chronometers it will generally be found that the oil has left one or other of the balance pivots; whereas in the

lever escapement where the drop is very small, and the impulse given on both sides of the arc of vibration the oil seldom or never leaves the pivot holes; a circumstance of no small importance; but although there are wonderful properties in the lever escapement, what is called the draw is so difficult to measure and to reduce to a minimum, that it tells very severely as the oil thickens; the duplex escapement suffers in the same degree as the chronometer.

The accompanying wheel and pallet will show you that I have endeavoured to modify the blow upon the impulse roller, by using a compound wheel like a duplex wheel with an Arnold epicycloidal tooth. It does well though I can give no decided opinion upon it.

Now I come to the consideration of your ideas upon the perfection of chronometers. The rule with us is that the perfection of timekeeping depends upon a perfect balance and balance spring; or a perfect pendulum; and an escapement whose arc of vibration is reduced to the smallest limit of angular interference with the arc of vibration, or of the balance. The smaller the angle of escapement is in comparison to the arc of vibration of the balance, the purer is the timekeeping property : thus

the arc of vibration/arc of escapement = $450°/22\frac{1}{2}$ = 1/20th is a very superior escapement; but requires both genius and greater care than the ordinary lever escapement of 45°, where $450°/45$ = 1/10th. There is no comparison of the superiority of the former over the latter.

In the Chronometer escapement it is difficult to construct them under 48° angle of escapement, as we cannot get dip enough into the escape wheel teeth, and consequently if the roller were made larger we should be running the risk of jamming the two lines of centres as the wheel's purchase of the roller is less than .03 of an inch. This long angle of escapement is a great drawback in a Pocket Chronometer, in fact it is a defect in this otherwise valuable escapement. The same remark of short angles applies also to clocks and an escapement of $\frac{1}{2}$ to $\frac{3}{4}$ of a degree with a vibration of 2° will give very superior results to one of $1\frac{1}{2}$ angle of escapement, and $2\frac{1}{2}$ arc of vibration.

Now supposing we adopt your view, which I certainly believe has a point of principle in it; if we were to adopt the wheel that was at one time much in use, and which I remember my father saying he had great success with, that is by keeping the same train and performing the same angular motion of the balance, and doing the same work, we shall be modifying the blow upon the impulse pallet. For example to produce 240 beats per minute we now use a fourth wheel carrying the second's hand of 80 teeth, and a pinion of 10 with 15 teeth in the escape wheel, and an impulse roller half its size; whereas if we employ a 4th wheel of 80 teeth with a pinion of 8 and an escape wheel of 12, the impulse roller to make the same angular motion must be increased in diameter in the inverse ratio of the escape wheel teeth, that is the diameter of the new impulse roller will be $15 \times 25/12 = 31.25$. We might increase the diameter of the escape wheel to 3/5ths of the balance and so obtain a large impulse roller, but it will involve a new construction of the calliper for space in the chronometer.

Theory and experience convince us that we cannot very much increase the present ratio of the diameter of the impulse roller to that of the escape wheel, because the dip into the wheel is in the ratio of the versed sine of the angular space between two teeth, which diminishes as the number of teeth is increased.

I will at once construct two chronometers upon the principle of your views and carry them out in extenso, and with your permission submit their results to you. The chronometer makers of the present day are more or less pupils of the old masters.

The callipers are almost universal : the diameters and weights of the balance are in accordance with the motive power, and the motive power I discovered to be in proportion to the cubic tenths of steel contained in the barrel; and by the collection of a large number of facts I found the equivalent momentum of the balance requisite to regulate and control such a force. No doubt the Exhibition of 1851 and the trials at Greenwich have done much to break down the miserable old system of keeping secrets. The numerous and earnest experiments made upon balances and balance springs are also becoming more known; but the modern literature of the art is very defective and poor. It is deplorable

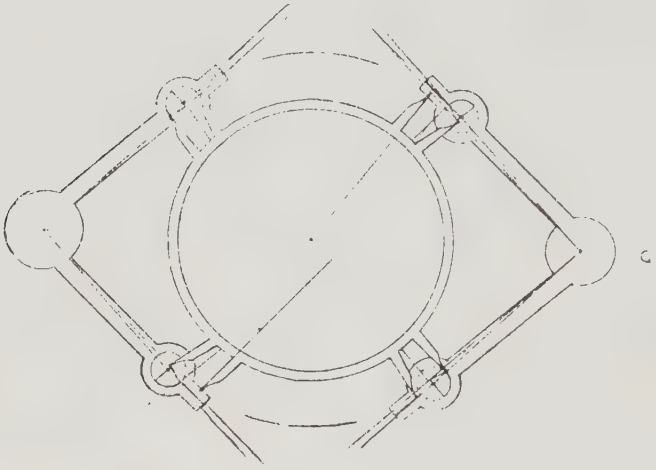
to think what information is thus likely to be lost ! Take for example : making wrong proportions in the Compensation Balance which will treble the middle error fault, instead of those found to be correct by long experience. The process of preparing the old steel, and the mode of hardening and tempering. I wanted Mr. Vulliamy in 1851 to make a Turret Clock upon the Harrison principle to go without oil, by covering the steel pivots with brass or gun metal, and letting them in lignum vitae bushes; and although this was not done, it was talked about a great deal at the time, as well as of employing wooden teeth in large machinery. Harrison's clock, so made, is the property of the Earl of Yarborough, and though it has been continually going for 140 years I could not discover the slightest sign of wear in any part. This process I find was adopted by engineers in their screw steamers, but they never thanked the clockmaker. I believe I was one of the talkers of the Exhibition of 1851, feeling great interest in the art, and some of my engineering friends caught up the idea, which has since made such a noise in the world.

What we want is more education in our workmen, and particularly elementary knowledge of mathematics and the habit of working by measurement instead of technical terms and sizes.

What Mr. Vulliamy did by his laborious drawings I do in a little time by figures. Many things appear to require a century to digest before they can be brought into practical use. Mr. Vulliamy used to adopt the Pin wheel escapement with 300 operations, but since I have been taking a great interest in the manufacture of turret clocks : I use but two pins as per diagram. I give the workmen the measures and they make the escapement, without hardly knowing what they are about. I confess I am surprised at the accuracy to which I have got these clocks to go, equal to the best Chronometers and astronomical clocks. In conclusion I think the reason of the first class Chronometers not increasing in proportion to the second class is in consequence of the former approaching so much nearer to perfection.

This rather lengthy letter has been quoted in full. One wonders what Airy's reaction was ! There are a number of interesting points in the letter. It tells us that Charles was sufficiently interested to

decide to make two chronometers along the lines suggested by Airy. The turret clock escapement using but two pins is most intriguing; are there any still in existence ?



To return to the use of a large impulse roller for use in a detent escapement. The normal roller is about half the size of the escape wheel. The idea of using a larger roller is to reduce the friction on the side of the balance pivot due to the blow of each tooth of the escape wheel when giving impulse to the balance at a point on the impulse pallet close to the axis of the balance staff.

There is no further mention of this idea until Charles wrote to Airy on August 3rd, 1870.

> Your suggestion of the large impulse roller failed as applied to the usual detached escapement; I however pursued it to its end which involved an entirely new construction of escapement in order to avoid the tripping caused by the increased speed of the large impulse roller. It is now ready for your inspection and trial.

However, it was not until September 16th that Airy replied :—

> Your letter of August 3rd has been constantly before me, but under peculiar office circumstances I have had no opportunity of coming to town in the morning, but I have the subject in mind and hope to call on you.

Unfortunately Charles died on January 11th, 1871, but on February 25th, 1871, Harrison Mill Frodsham took up the matter and wrote to Airy asking permission to send for his inspection a marine chronometer with extra large roller as suggested by him to Mr. Frodsham some time ago. To which Airy replied that he would be glad to try it, that he would like to see it and that, if there is no model or description which he could examine, he would be glad to have it opened by a proper person for him to see.

The last mention of this escapement is contained in a note dated April 17th, 1871, " The 3 chronometers belonging to C. Frodsham (experimental with large roller, etc.) were returned to him to-day. W.E.".

Gould (page 135) tells us a little more about its design. " The plan necessitated, however, an entire reconstruction of the movement, including an extra wheel in the train, while the increased angular velocity of the impulse pallet rendered it extremely difficult to get the escape wheel, after unlocking, under way in time to give the former any impulse at all. It must be remembered that in the chronometer escapement the escape wheel, starting from rest, has to overtake, and give impulse upon the rapidly swinging impulse pallet, and in consequence its moment of inertia must be very considerably less than that of the balance. In fact, a perfectly proportioned escapement, set correctly in beat, might be rendered absolutely useless by the fitting of too heavy an escape wheel."

Finally, Airy, in his Report to the Board of Visitors, said, " I proposed to the late Mr. Charles Frodsham to meet this by use of a broader pallet and a lighter impact of longer duration. The decease of that accomplished horologist prevented the completion of trials which he had commenced for carrying out my suggestion."

Carriage Clocks and Small Mantel Clocks

Frodshams appear to have used a special series of numbers for all types of clocks excluding marine chronometers. Examples of some of the styles they adopted are shown in **Plates 58 - 61**, pages 401 - 404. These nearly all had lever escapements but some of the best carriage clocks had detent escapements and the finest

examples of all had the typical Frodsham balance as seen in No. 1560. **Plate 62**, page 405.

One important example of a Frodsham carriage clock with a detent escapement is No. 847, AD Fmsz. It is important because it has a silver case bearing the hallmark for 1851. This is, of course, a great help in dating some of the early carriage clocks. It is also an additional proof that AD Fmsz stands for 1850. See page 100.

Another fine example of interest is a mantel clock in a gilt metal case. It has a detent escapement with an Earnshaw type balance, and has a month duration with an up and down indicator. This clock bears the number, No. AD 1/FMSS, which suggests the year 1855 as the date of manufacture. This is the only variant of AD Fmsz which has come to light so far. As already pointed out AD Fmsz represents 1850, and these letters were applied to a variety of high-class watches from 1850 onwards. AD Fmsz therefore indicates the quality of the watch and not the date of manufacture.

Details of a number of clocks of these types are to be found in *Carriage Clocks*, written by Allix and Bonnert.

Ships' Clocks, 84 Strand, London

No. 922. At Arlington Court, Devon, there is a Marine chronometer mounted as a mantel clock, and striking the bells of ship's watches instead of the hours. It is believed to have come from Sir Bruce Chichester's yacht, the 'Erminia', a schooner of 276 tons.

No. 1348. A 2-day Bulkhead clock with duplex escapement.

Regulators. 84 Strand, London.

No. 1165. A month duration wall regulator with a twin jar mercurial pendulum.

No. 1607 A month duration wall regulator with a mercurial pendulum.

No. 1870 A month duration standing regulator with a mercurial pendulum.

No. number. A month duration standing regulator with a mercurial pendulum, but it is signed 'Frodsham, London.' only. It is therefore possible that this is one of the Gracechurch Street examples.

Charles Frodsham's Death

He died on the 11th January, 1871, aged 60, at his home at 26 Upper Bedford Place, in the presence of his son, Harrison Mill Frodsham. His death certificate tells us that his death was due to liver disease and dropsy. This indicates that his death was not a sudden one and that he must have been incapacitated for some months. This explains why Charles did not go to see Airy at Greenwich in August, 1870, but expected Airy to come to him. His illness probably commenced in about May, 1870, when he made his Will.

Will of Charles Frodsham — dated 25th May 1870.

James Duncan, William Frost and **John Mill Frodsham** were appointed as trustees.

Elizabeth Frodsham (his wife)

£18,000 to be invested by his trustees to produce £800 per annum
£300 to be paid as soon as possible
All furniture etc. and all household goods at his residence, 26 Upper Bedford Place
To be Guardian of his children

John Mill Frodsham (his eldest son)

7 Orange Street (a house and two shops), occupied by John Davies, a furnishing undertaker.
Freehold land in Egham, Surrey
84 Strand. But the purchaser of the goodwill of the business to be allowed to rent the premises for 30 years at a yearly rental of £250 (this sum to be put into the general trustee account). Until a purchaser of the goodwill is found, the business is to be carried on by trustees. To make up for John Mill Frodsham not receiving this rental, he is to be given £2000
1/3 share of his printed books and manuscripts (other than those used in the business)
A Carriage Clock or a Regulator
A silver salver presented to him by the Clockmakers Company
½ his Medals of Honor
£100
1/6 share of the Residue of his estate, to be invested by the trustees

Harrison Mill Frodsham
1/3 share of his printed books etc. (other than those used in the business).
A gold watch value £32
½ his Medals of Honor
£3,000, to be invested by the trustees
1/6 share of the Residue of his estate, to be invested by the trustees.

Hannah Moore (his daughter)
1/3 share of his printed books etc. (other than those used in the business).
A silver salver also presented to him by the Clockmakers Company.
£3,000 to be invested by the trustees
1/6 share of the Residue of his estate, to be invested by the trustees.

Euphemia Mill Frodsham
£3,000 to be invested by the trustees
1/6 share of the Residue of his estate, to be invested by the trustees.

William James Holmes Frodsham
A gold watch value £32
£3,000 to be invested to produce £150 per annum
1/6 share of the Residue of his estate, to be invested by the trustees.

Robert Cecil Frodsham
A gold watch value £20
£1,000 to be invested by his trustees
1/6 share of the residue of his estate, to be invested by his trustees.

James Duncan
£150 if he shall act as trustee

William Frost
£150 if he shall act as trustee.

George Moore (son in law)
£100

James Mill (brother in law)	a legacy of £21	
Herbert Frodsham (nephew)	£21	
Arthur Frodsham (nephew)	£21	
Hannah Louisa Frodsham (niece)	£21	
Fanny Frodsham (niece)	£21	
Eliza Page (cousin)	£21	
Isabella Nicholls (daughter of the late John Charles Gibbons)	£21	
Eliza Frost (sister)	£10.10.	
Emma Rennick (sister)	£10.10.	
Charlotte Gorton (niece)	£10.10.	
Emily Maughan (niece)	£10.10.	
Agnes Frodsham (niece)	£10.10.	
Charles Frodsham Frost (Godson)	£10.10.	
William Frodsham (brother)	£10.10.	
William Alexander Jones (assistant)	£105.	
Alfred Jolley (assistant)	£105.	
Thomas James Stafford (assistant)	£52.10.	
Timothy Bishop (clerk)	£52.10.	
Eliza Stafford (house keeper)	£31.10.	
Robert Watkins (assistant)	£42	in addition to any amount which may be owing by him at my death
Clock Makers Asylum at Colney Hatch	£105	

Charles Mill Frodsham

£3,000 to produce £150 per annum. This was to be invested by his trustees, but in a Codicil dated 25th May 1870 this £3,000 was to be paid into the Court of Chancery.

If any of his six brothers or sisters were to die, Charles Mill was not to be entitled to any part of their sixth shares.

Charles Mill would therefore appear to have displeased his father in some way. Was it because he had married Susan Cockett Tytherleigh on January 13th, 1869 ?

More will be said about this later.

Probate

Charles Frodsham's estate was valued for probate purposes at under £70,000.

A Fortune in Chancery

1852 There appears to have been an advertisement in the *" Times "* for " next of kin ".

1855 Early in August a Mr. Adams, calling himself "A Proctor at Doctors' Commons ", called on Mrs. Frodsham (Aunt Jane) of Holloway (who must have been the widow of John Frodsham, the brother of William James Frodsham), and told her that there was £40,000, left by a Frodsham, somewhere about the year 1794, which, if not claimed soon, would go to the Crown. Mr. Adams said his sister had an interest in it, which was the inducement for him to call. Aunt Jane took no trouble about it, but told him that Mrs. Alice Gorton and Miss Mary Frodsham of Clapton (the two sisters of William James Frodsham) were the nearest relatives, and gave him their address; but he never called there.

1855 An advertisement was placed in the *" Times "* of 8th August.

> " To next of kin. The Gentleman who called on Mrs. Frodsham of Holloway respecting a Will, would confer a favour by leaving his address with her, or with Mrs Gorton, 11, Clapton Terrace, Upper Clapton."

1855 Mrs. Charles Frodsham wrote to Mrs. Henry Frodsham on the 10th August.

> " The person alluded to in the advertisement was the brother of your great-grandfather, the Watchmaker, he lived in London, and the individual from whom you expect this fortune by

accumulation died in Cheshire and his Will, must have been proved in Cheshire, if he made one.

For the sake of curiosity, Charles says, it would be worth while to inquire if there was such a Will."

The Proctor who called on Mrs. Frodsham is believed to have been Richard Addams [sic] who died in 1875.

1898 - 1900 Hyrum Plumer Frodsham, an L.D.S. missionary (" Latter-Day Saints "—a Mormon), came to England and, through a solicitor, he was able to establish the claim to money in Chancery, as from **Edward Frodsham, the Watchmaker**. The result was that £30,000 was received from Chancery, of which 50% was claimed by the solicitor. The remainder was divided between the heir, Joseph Frodsham (brother of Hyrum), and Hyrum himself, as descendants of James Frodsham (their father) and Edward Frodsham (their grandfather). For the American family tree, see **Appendix V**.

This Edward Frodsham was a watchmaker who was born in 1791 and died at Eccleston, St. Helens, Lancashire, in 1841. He had eight children, and even if he died intestate, it seems unlikely that his estate would have remained unadministered for sixty years. Could the ancestor, whose fortune was placed in Chancery, have been this Edward Frodsham's uncle ?

Were there perhaps two fortunes placed in Chancery, one claimed soon after 1855, and the other claimed in 1900 ?

Unclaimed Frodsham Property

Chamber's *Index to Heirs at Law, next of kin, owners of unclaimed property : missing friends and Legatees, advertised for during the last 150 years. —date 1878*, mentions the following :—

Frodsham family,	27,109
John Frodsham,	66,713
Mrs. Frodsham,	38,384
Thomas Frodsham,	6,665

There is no mention of an Edward Frodsham, so that it is still not clear how Hyrum Plumer Frodsham managed to prove his ancestry. The mystery has yet to be solved.

The destruction of the Family Bible.

There is a story concerning Edward Frodsham's family bible, which he had handed down to James Frodsham, who had then passed it on to his eldest son, Claude (not shown in the family tree), who was the brother of Hyrum Frodsham. Claude, a mormon, went to live in Montana taking with him his wife, a New Englander, who was fiercely antipathetic to the L.D.S. When their house caught fire, Claude's first thought was to save the family bible; this he succeeded in doing. His wife, however, snatched the bible from him and threw it back into the flames of the burning house.

This family bible might well have shown how the American branch was related to the London families.

Addendum to page 83

There is one more chronometer inscribed " Restored by Charles Frodsham, 1846 ". This is J. R. Arnold No. 548, and this also has been given an Airy's bar. The balance, presumably applied by Charles Frodsham, is most unusual in that it has a somewhat concave cross-bar which is " bimetallic ". This cross-bar acts as the arms of the balance and carries the normal bimetallic rims of the balance. Hartnup used a single bimetallic cross-bar in some of his earliest experiments in about 1847. No. 548 was in the hands of Charles Frodsham from November, 1845, until March, 1846. It was returned to Charles in 1850 and again from August, 1854, until June, 1855, so that this unusual balance could have been applied at any of these times.

CHAPTER IX

THE FAMILY OF CHARLES FRODSHAM

As already stated, Charles had married Elizabeth Mill (daughter of John Mill of Montrose and Frances née Jebb of Newark, Notts) on the 28th April, 1834. They had ten children one of whom was stillborn, their names were as follows:—

John Mill Frodsham

He was born on the 6th February, 1835, and was the first to break the tradition in the family of becoming a watchmaker. He was trained at King's College, London, and became a doctor of medicine, obtaining his M.R.C.S. in 1856, and his M.D. in Edinburgh in 1857. He became a house-surgeon at the County Hospital, Carlisle. He later became a J.P. for Surrey; Associate, King's College, London; Member, Royal Medical Society, Edinburgh, and Pathological Society, London. Late Medical Officer, Magdalen Hospital and Westminster Refuge, Streatham. Senior Physician, Farringdon General Dispensary and Lying-in-Charity Physician, North London Hospital for Consumption, and Royal Pimlico Dispensary. Medical Examiner, St. Anne's Royal Asylum. He wrote an article on the "Treatment of Goitre by External application of Biniodide of Mercury" for *The Lancet*, and one for the *Medical Mirror* on "Alopecia".

He married Therese D'Iffanger on January 30th, 1866. Their first child was born on November 19th, 1866, but was unfortunately stillborn. After this they had eight children (see their Family Tree). **Appendix III.**

In 1879 they were living at Denham House, Upper Streatham, but when he died on May 12th, 1907, he had been living at Bardowie, Weybridge. His effects were valued at £20,838.7.4.

Charles Mill Frodsham

He was born on the 20th July, 1836. In 1847 he entered King's College School, where boys were trained specially for trade or

business careers. His school reports said that he was " talkative and troublesome in class ". However, on May 24th, 1852, when he was 15 years old, he was apprenticed to his father, Charles Frodsham, for seven years. 5/-. It would appear that after completing his apprenticeship he continued to work for the firm.

In 1861 he was put in charge of the newly acquired firm of Grimalde and Johnson of 50 Strand, " for that season ", that is to say, until that shop was closed down at the end of that year.

In 1861 he submitted his first two-day marine chronometer for trial at Greenwich.

No. 3/3250, its rate was not too good and its trial number was 71.9. In 1862 it was again submitted for trial, probably with an improved balance, and its rate was very much improved, gaining a trial number of 37.4.

No. 3/3308, was also sent for trial in 1862 and came 11th, with a trial number 31.8. In 1863, it was again tried, but this time it came 26th, with a trial number of 44.3. However, when it was again tried in 1865 with " Usual balance with continuous auxiliary ", it was awarded 5th place with a trial number of 23.9.

No. 4/3348, was submitted in 1863 with a " New construction of balance " and was given a trial number of 53.1. In 1864, when it was tried with " New auxiliary for all temperatures " it won 4th place with a trial number of 23.2.

No. 3362, was the last of his chronometers submitted for trial. When it was tried in 1865 its trial number was only 89.5, and on re-trial in 1868 it obtained a trial number no better than 81.8.

To return to No. 3/3308, which is still in existence, apparently in its original condition just as it was sold to the Admiralty in 1865. It was used in the Transit of Venus expedition of 1874, and was sent to Egypt (see *Edward John Dent*, page 564), and remained in the possession of the Admiralty until 1963.

No. 3/3308 is most interesting. As recorded in the trial records it has the " usual balance with continuous auxiliary ", and it is this continuous auxiliary which is most ingenious. As can be seen in the diagram, it has a fine wire passing from the central area of the

balance to a spring-loaded affix on the inner side of the bimetallic rim of an ordinary balance. From the free end of the balance rim there is fixed a rod which passes to the centre of the fine wire, and engaging the fine wire by means of two vertical pins, one on each side of the wire. When the free end of the rim moves either inwards or outwards the affix is always pulled inwards. In other words, Charles Mill Frodsham had contrived a most ingenious and simple device for counteracting the middle temperature error, i.e., the tendency for chronometers to lose when exposed to unusual heat or to unusual cold. By pulling the affix inwards the balance will speed up sufficiently to overcome the loss due to extremes of temperature. **Plates 38 - 39**, pages 380 - 381.

In 1860 Charles Mill was elected to the Council of the British Horological Institute, and on January 12th, 1863, he was made Free of the Clockmakers' Company.

On the 13th January, 1869, at the age of 31 (according to the Register) he married Susan Cockett Tytherleigh, a spinster aged 22, the daughter of a " Gentleman " named Thomas Richard Tytherleigh. But they were married in " The Register Office " at Pancras. There is no mention of any relative of Charles Mill being present at the ceremony, but Susan's father was present. The other mystery is that the bride and bridegroom both gave 100 Camden Street as their address. Now on examining the Post Office Directories we find that 100 Camden Street was occupied by a dentist named Andrew Burns.

It would seem that Charles Frodsham did not approve of this marriage, and this could explain why, when Charles Frodsham made his Will in May, 1870, Charles Mill was only left £150 a year and no share in the residue of his estate, and no gold watch.

Charles Mill Frodsham died on the 23rd of September, 1881, at 69 Leverton Street, Kentish Town. He failed to make a Will, and when his estate was administered he was described as a widower. His estate was valued at £68.18.0. and administration was granted to his brother, John Mill Frodsham. When he died he was 46 and his death certificate states that he was a " Gentleman " and that his death was due to " Intemperance, many years. Paralysis of the Insane, 2 months. Coma 5 days "; suggesting that he may have

had syphilis. Note that he was not described as a chronometer maker as he had been in his marriage certificate.

Susan Frodsham appears, therefore, to have died during her husband's lifetime, but I have been unable to find the record of her death in spite of searching the registers from January, 1869, to January, 1882. There is no mention of Susan in Elizabeth Frodsham's Will which was drawn up on the 27th May, 1878, so that it seems probable that Susan was no longer in the picture at that time, though it is possible that Susan and Charles Mill may have been divorced prior to this date. Her death, therefore, remains a mystery, but there is one more problem and this concerns her birth. I had been unable to find a record of her birth in the years 1846, 1847 and 1848, in the name of Susan Tytherleigh.

However, after much cogitation, it occured to me that Susan's second name, " Cockett ", was a little unusual. Could that have been her name at the time of her birth ? Sure enough, on searching the records of birth, a " Susan Cockett ", born on the 6th November, 1846, was discovered. The birth certificate shows that she was the daughter of Mary Ann Cockett, and that Susan was born at No. 2 Grove Street, Saint Mary, Southampton, Hampshire. The spaces for the name and the occupation of the father were left blank, and Mary Ann made a mark as her signature.

Susan was therefore an illegitimate child and was either adopted by Thomas Richard Tytherleigh or, perhaps Mary Ann had married him; he may even have been Susan's father, but the fact remains that Susan was born out of wedlock.

One can now begin to understand why Charles did not approve of the marriage of his son to a " bastard ", however much Charles Mill may have been in love with her.

On further investigation, no record can be found for the baptism of Susan at St. Mary's Church, so that it is possible that she was never baptised, and, if so, this could explain why she had to be married in a Registry Office. However, the baptism of Susan's mother, Mary Ann Cockett, has been found in St. Mary's Registers, on October 12th, 1828, when she was $2\frac{1}{2}$, her parents being William and Mary Cockett. William being a mariner. The records of their other children show that they changed their place of residence four

times in four years. They probably lived in lodgings. Mary Ann would therefore have been 20 when Susan was born.

It is indeed sad to think that Charles Mill Frodsham, a brilliant horologist, who had shown great spirit by marrying an illegitimate girl against the wishes of his father, should have ended his days as a lonely alcoholic, but this was the penalty in those days for disobeying one's parents.

Frances Mill Frodsham

Was born on the 9th April, 1838, and died on the 24th October, 1868, when she was 30 years old, at 26 Upper Bedford Place. Her effects were valued at under £600.

Hannah Mill Frodsham

Was born on the 7th December, 1839, and married George John Moore, a watch manufacturer, on the 16th April, 1868. They had two children.

Euphemia Mill Frodsham

Was born on the 14th December, 1841, and married Captain Henry de Parry Rennick in 1875. They had one child.

Janet Mill Frodsham

Was born on the 29th May, 1847, and died on the 5th April, 1862, aged 14.

Harrison Mill Frodsham

He was born on the 2nd July, 1849, and died at Rochford on the 24th September, 1922. He became a watchmaker, probably working for the firm, although never officially apprenticed to his father. When his father, Charles Frodsham, died in January, 1871, Harrison Mill was only 21, nevertheless he appears to have taken charge of the thriving business. He became an expert horologist and, as we shall see, he wrote an excellent series of articles for the *Horological Journal* in 1877, and, in the same year he applied for a Patent.

He married Edith Susannah Rutherford, prior to June, 1878 (she is mentioned in Elizabeth Frodsham's Will which was drawn up on

May 27th, 1878), but the record of this marriage has yet to be found. Edith Susannah was born at Cambridge towards the end of 1848, and was registered as "Susannah Rutherford". She outlived her husband and died on the 24th May, 1928, aged 78 (according to the register). For the Probate of her Will her effects were valued at £176.10.1.

Harrison Mill Frodsham will be discussed in greater detail in the next chapter.

William James Holmes Frodsham

Born on the 31st July, 1851, he was another of Charles' sons who did not become a watchmaker. He joined the Army and became Colonel of the East Surrey Regiment. He married Thomasina Dora Travis Swire (step-daughter of John Rose of East Markham). They had four children (see Family Tree), and James Hugh Swire Frodsham now owns the Charles Frodsham Family Bible.

Robert Cecil Frodsham

The last child of Charles Frodsham was born on the 16th June, 1854. There is no suggestion that he became a watchmaker.

When his father died in 1870 he was left £50 a year, and 1/6 share in the residue of his estate. When his mother died in 1879 she had made him the sole executor of her estate valued at £800, of which he was to be the residuary legatee.

So much for Charles Frodsham's children. Let us now consider his wife :—

Elizabeth Frodsham

She continued to reside at 26 Upper Bedford Place after her husband, Charles, had died until her own death on the 3rd July, 1879. Her Will, made on the 27th May, 1878, is interesting. She seems to have remembered all her surviving children, and all her sons and daughters-in-law and their children :—

Robert Cecil Frodsham, her youngest child, was made sole executor and was given a large silver salver and bequeathed the residue of her personal estate.

John Mill Frodsham was given the enamelled portrait of his sister, Fanny.

Charles Mill Frodsham to have the two silver salt cellars marked with his initials and his christening spoon and fork and also a wooden clock which stands on the back drawing room chimney piece and the picture done by herself.

Hannah Moore, a large china looking glass, a dressing table, a picture called " Jealousy ", and her sapphire ring, onyx earrings, pearl brooch, and the silver cream jug marked with the letter " M ".

Euphemia Mill Rennick, her small diamond ring, a small china looking glass, a cream jug and the locket marked with the letters " C.E.F." in pearls.

Harrison Mill Frodsham, a small silver salver, a large diamond ring and the four pictures of his grandparents on either side, Frodsham and Mill, and the engraving of eminent men of 1807 and 1808, and also her gold chain with the half sovereign coin attached and the octagonal oak table.

William James Holmes Frodsham, her emerald ring, cameo brooch with the likeness of his father, the chronometer clock kept in the spare bed room, also the two engravings of Landseer's pictures and one of Rosa Bonhear's.

Effie Therese Frodsham, her granddaughter, her small enamelled gold watch set with diamonds and her long gold chain.

Mabel Frodsham, her granddaughter, one of her lockets with hair, chain attached.

Alice Maud Emma Moore, her granddaughter, her small gold watch.

Frances Elizabeth Moore, her granddaughter, the other locket with hair, chain attached, and one of her work boxes.

Theresa Frodsham, her daughter-in-law, her oak travelling clock and hair bracelet.

Edith Susannah Frodsham, her daughter-in-law, her tortoiseshell work box and her work table.

Henry de Parney Rennick, her son-in-law, the pedestal watch stand with figure of Napoleon under glass case.

George John Moore, her son-in-law, the barometer in case and pedestal which stands in the hall.

There were also legacies to William Senior Dean, Louisa Newball and Mortimer Sullivan. Any remaining plate or plated ware to be divided equally between her sons and daughters.

The two most interesting points in the Will are, first, that she appears to have forgiven Charles Mill Frodsham although he seems to have become the black sheep of the family, and secondly, as already pointed out, there is no mention of Charles Mill Frodsham's wife, Susan, suggesting that either she was dead or else that she was not accepted as a member of the family.

CHAPTER X

CHARLES FRODSHAM & CO.

It is not quite clear what happened to the firm on the death of Charles Frodsham. In his Will he stipulated that the purchaser of the goodwill of the business should be allowed to rent the premises at 84 Strand for 30 years at a yearly rental of £250, and that until a purchaser should be found the business was to be carried on by his trustees. Even if Harrison Mill Frodsham agreed to purchase the goodwill he would still have to pay the £250 per annum rental. It seems likely that he came to some arrangement with the trustees which enabled him, in some way, to buy the goodwill.

We can assume that **Harrison Mill Frodsham** took charge of the firm soon after January, 1871. He would have been 21, and, not having been apprenticed to his father, he may well have had little experience in the running of a business.

Gravity Escapement

He wasted no time and straight away become involved in the use of new ideas, accordingly on the 25th February, 1871, he wrote to Airy :—

> I beg to ask permission to be allowed to send to the Observatory for trial an astronomical regulator with Mr. Frodsham's last application of the gravity escapement. We have been asked to supply a clock for an American Observatory, and it would be a great thing to have our opinion of this clock confirmed by yourself.

To which W. H. M. Christie, on behalf of the Astronomer Royal, wrote to say that he would be very glad to receive it.

It would indeed be interesting to know more about the design of this gravity escapement. Was it the two-pin escapement which

Charles said that he used for turret clocks, or was it an improved version of this escapement ? So far this remains a mystery.

Galvanic Chronometer

On the 19th August, 1871, Harrison Mill wrote again to Airy :—

> I beg to ask permission to be allowed to show you a new Galvanic Chronometer which we have just made for the Allegeny Observatory, U.S.
>
> It is a break circuit, and its peculiarity is that it can be brought to time if it be too slow or too fast at any time; by means of a moveable stud acting on the balance spring without injuring the rate. It would give much satisfaction to have your approval and opinion on it.

One wonders whether this is still in existence ?

Found at Omdurman

Marine chronometer, Charles Frodsham, No. 3533, was sold, with another chronometer, in 1871, to Sir John Fowler, who was then carrying on some important railway work in Egypt. In 1898 Frodshams received a letter from an officer in the Sudan to say that this chronometer was found when Omdurman was occupied after the defeat of the Dervish forces under the Khalifa.

St. Mark's, Victoria Park

The firm had been commissioned by the Queen to make the presentation tower clock in 1873.

Honours and Awards

Naples Exhibition, 1871. First Class Gold Medal.

Greenwich Trials, 1871. No. 3423 with new reverse balance obtained the first Admiralty Premium with a trial number of 15.2.

Philadelphia Exhibition, 1876. Medal and diploma.

Special Loan Exhibition at South Kensington, 1876

In addition to a marine chronometer fitted with a galvanic interrupter for chronographical purposes, Charles Frodsham and

Co. exhibited a regulator with an improved gravity escapement, as arranged and patented by A. J. Higham in 1875. No. 2917.

Paris International Exhibition, 1878. Juror.

Hutton Chronometer No. 138

This was the heading on a letter dated 25th June, 1875, from Charles Frodsham and Co., to the Astronomer Royal, which reads :—

> We have the pleasure to acknowledge the receipt of your esteemed favor of this date with reference to the above chronometer.
>
> The action is taken from a continuous motion clock or Chronograph in which the raising of a drum over a fly diminishes or increases the rotation according to the amount of air admitted—but we should think that its action, as far as regards compensation will be most difficult to ascertain without a set of experiments for the special purpose.

W. H. M. Christie replied the following day to say that the Astronomer Royal would be glad to have the wooden drums, etc., removed from the chronometer and returned to the Observatory.

In the 1846 Greenwich Trial, Hutton No. 138 was first in point of merit, whilst in the 1847 Greenwich Trial, Frodsham No. 2074 was first, both were purchased by the Admiralty for £68.5.0.

John Hutton's chronometer is of particular interest because in 1846 he took out a patent, No. 11427, for an auxiliary compensation of an unusual design. He placed a closely fitting boxwood cap around and over the balance of the chronometer and found that by raising or lowering this cap he could effect a considerable alteration in the rate, the chronometer going faster for a larger clearance, and slower for a smaller. Having first ascertained that the balance spring was isochronous, and that therefore the effect produced was not to be attributed to the chronometer being slow in the short arcs, he mounted the boxwood cap upon a system of levers controlled by a compensation curb, which reduced the clearance at middle temperatures and increased it at the extremes. See " Gould ", page

197. John Hutton was a London maker of chronometers who worked in 1830 in Commercial Road, E., and from 1830-1868 in Mark Lane.

The effectiveness of this most ingenious idea must have been proved by the fact that it was " first " in the 1846 trial. It is difficult to understand why Airy decided to have the boxwood cap and its system of levers removed. It is doubtful whether another such chronometer has survived unscathed.

Harrison Mill Frodsham would almost certainly have been the one to examine this chronometer and it is hard to believe that he did not understand the action of the wooden drum, and that therefore one would have expected him to try to dissuade Airy from having the device removed.

Of one thing we are quite certain, Harrison Mill Frodsham was a keen horologist with a great knowledge of the subject, and at the same time he was a man of ideas. Five years after taking charge of the firm he applied for a provisional patent.

Patent No. 2912. A.D. 1876, July 15 Harrison Mill Frodsham

" Independent Equimotive Escapements for Watches, Clocks and other Timekeepers."

The impulse to the balance or pendulum is given by an impulse lever actuated by a tensed spring. The spring is tensed to an equal degree for each impulse, thereby rendering the force of the impulse a constant quantity. At the moment of completing the impulse to the balance in one direction the impulse lever ceases to be with it, but goes on a little further and unlocks the train; it is then itself locked, and remains locked whilst its spring is being tensed so that it is ready to give impulse in the opposite direction. The balance, on its return vibration, unlocks the impulse lever, which in its turn unlocks the train, as above, and so on; in this way the resistance to be overcome by the balance in order to unlock the train is always the same. This provisional patent was not illustrated.

In other words, a constant force escapement, which, as we shall see, was one of Harrison Mill Frodsham's great interests. This

patent was improved and a full patent was applied for six months later.

Patent No. 191. A.D. 1877, January 15

" Improvements in Equi-motive Escapements for Watches, Clocks and other Timekeepers."

In effect this is an enlarged and revised edition of the above provisional patent.

As can be seen from the diagrams (**Plates 40 - 42**, pages 382 - 384) the escapement is much too complicated, but, like Ulrich's patents, it is most interesting. The following is a description of the diagrams as given in the specification :—

Figures 1 and 2 illustrate on an enlarged scale my Invention in a simple form as applied to a balance.

Figures 3 and 4 illustrate a modified form in which the locking of the impulse lever is simplified and that of the train lightened.

Figures 5 and 6 show a form in which the lever impulsed by the spring (instead of imparting motion to the balance) acts upon the faces of a pair of similar pallets, the extremity of this lever being formed as a segment of an ordinary escape wheel, having but two teeth pointing in opposite directions.

Figures 7 and 8 show a further variety in which the spring C may be made to act as the lever itself to give impulse to the balance.

Figures 9 and 10 show another way of locking the impulse lever.

Figures 11 and 12 show how the invention can be applied to a pendulum. The impulse pin *e* being attached to the pendulum at a point suitable to give the required arc.

Nine years later, Harrison Mill described yet another variant of the last type in which the impulse is given to the pendulum at the bottom of the pendulum bob, as shown in detail in **Plate 43**, page 385.

Before taking out his patent he must have made a study of other

remontoire escapements. He therefore decided to make use of his research in order to produce : *Some Materials for a Résumé of Remontoires.* By Harrison Mill Frodsham.

The Horological Journal produced a series of articles under the above heading, commencing in October, 1877, on page 21. They form a splended résumé of the whole subject and each article is well illustrated.

Remontoires, he said, may be divided into four classes :—

1. Train remontoires in which the weight or spring wound up by the train drives the escape wheel. Harrison's rewinder, in his prize marine chronometer, was of this kind. Aitkin's escapement was another. (*Society of Arts' Transactions*, 1824).
2. Those in which the pendulum or balance does not find the " maintainer " wound up, but the train has to effect the rewinding, when the pendulum or balance unlocks it. The Astronomer Royal's duplex spring escapement illustrates this method.
3. Those in which the rewinding is done when the pendulum or balance is out of the way, but the train has to be unlocked by the pendulum. Mudge's escapement, see *Horological Journal*, Vol. II, page 17, and Mudge's own description.
4. Those in which the pendulum has only to unlock the maintainer, and the unlocking of the train is effected by the maintainer when the pendulum is out of connection with it; see Breguet's and Garnier's escapements, given in the September issue of the *Horological Journal* for 1877, page 4, where Harrison Mill Frodsham describes these two escapements.

Following this classification he then describes the following remontoires invented by :—

John Aitkin of 55 St. John Street. Pertaining to Class 1. A.D. 1824.

G. B. Airy, Astronomer Royal. Duplex spring escapement. Class 2. A.D. 1841.

M. Couet page 49, *H.J.* Dec. 1877. Class 1. A.D. 1862.

Gravity Escapements

Mudge, arranged á la Denison
Mudge's Gravity Escapement.
Kater *Philosophical Transactions*, Vol. 130 Part 2, p. 335
Class 4.

Bloxam
Massey Patent No. 3854 A.D. 1814
Voss and Monnington, of Hamburg. In Soul's Patent No. 2822
Class 2. A.D. 1868
M. Detouche's arrangement of the Voss and Monnington type
Gehrckens of Hamburg. See Soul's Patent No. 850.
Class 3. A.D. 1871

Balance Escapements page 66, *H.J.* Jan. 1878

R. May *Society of Arts Transactions* Vol. 46, page 54 A.D. 1828
Melvine *Society of Arts Transactions* Vol. 46, page 58 A.D. 1828
Breguet's detached constant-force escapement
Massey Patent No. 3584 A.D. 1824
Hanriot *Society of Arts Transactions.* Vol 50, page 112.
H.J. Feb. 1878, p. 76 A.D. 1834
Brosse *Revue Chronomique.* Vol vi, page 128
Verité ,, ,, Vol. x, page 398
Mathew Patent No. 3125 A.D. 1808
Moenk
Fleury
Tavan *Description des Eschappement*, page 48 A.D. 1804
De Chalonge *Revue Chronomique.* Vol. iii page 252 and 299
Haley Patent No. 2132 *H.J.* March 1878, page 88 A.D. 1796
Mudge
De Lafons *Society of Arts Transactions.* Vol. XIX, page 331.
H.J. April 1878, p 104 A.D. 1801
Brosse
Verité Exhibited Paris. *Revue Chronomique*, Vol. VI,
p. 65 & 72 A.D. 1839
John Harrison *H.J.* May 1878, page 120

Ulrich Patent No. 5,136	*H.J.* June 1878, page 131	A.D. 1825
Herrmann Patent No. 2447		A.D. 1866
Gowland Patent No. 7456		A.D. 1837
Benoit *Revue Chronomique*, Vol. IV, page 500		
Pierre Gaudron see F. A. Lepaute's *Traité d'Horlogerie*, and Thiout, 1741		
Lebon	*H.J.* Jan. 1879 p. 58	
Thiout's improvement see Thiout's *Traité d'Horlogerie*, Vol. II p. 206		
Wagner *Revue Chronomique*, Vol. I, page 209		

The information provided by Harrison Mill Frodsham's résumé could well be used as the foundation for a book on this most fascinating subject. Charles Frodsham wrote in 1862 in *"A few Facts, etc."*, " Perfect timekeeping by the remontoire escapement is ' the watchmaker's philosophers stone ' The remontoire is as false in its results as its principles are alluring and plausible; it has its uses in large turret clocks, but is quite abandoned by the experienced chronometer maker."

In another article on page 132 of the *Horological Journal* for June, 1878, Harrison Mill Frodsham describes the Breguet " Synchronizer ", the property of Her Majesty the Queen.

Harrison Mill Frodsham has thus shown himself to be by no means an ordinary clockmaker, but an expert in his field.

Difficulties

It must be appreciated that in the 1880s the entire English watchmaking trade, with their largely hand-made products, were finding it more and more difficult to survive against the increasing competition from the Americans and the Swiss who were producing high-grade machine-made watches. It is therefore in some ways remarkable that a few firms, such as Frodshams and Dents, did manage to survive and to succeed in producing watches of superb quality.

Harrison Mill's fascination with the theoretical side of horology may perhaps have caused him to neglect the practical side of the business. It must be remembered that he was never officially

apprenticed to his father so that his knowledge of the running of a business may have been limited. It is probably fair to surmise that by 1883 the firm was in some financial difficulty, and we find that by 1884, the firm's title had changed to :—

Charles Frodsham & Co.

84 Strand was still the place of business. The " & Co." seems to suggest that this was the date when **George Moore** became a partner; he was a notable watch manufacturer who had succeeded to the business of F. B. Adams & Sons of St. John's Square. However, having retired from business for some years, he died in 1894, at the age of 80. His son, George John Moore, had married Charles Frodsham's daughter, Hannah Frodsham, in April, 1868; George John was also a watch manufacturer.

On the other hand, 1884 could be the date when **Sophus Emil Nielsen** was made a Director of the firm. Nielsen was a first-class watchmaker having great experience in the practical side of the business and, of course, Harrison Mill would now have had someone capable of putting his thoughts of inventions into practice. One of Harrison Mill's most interesting ideas was the :—

Frodsham Trochilic Escapement

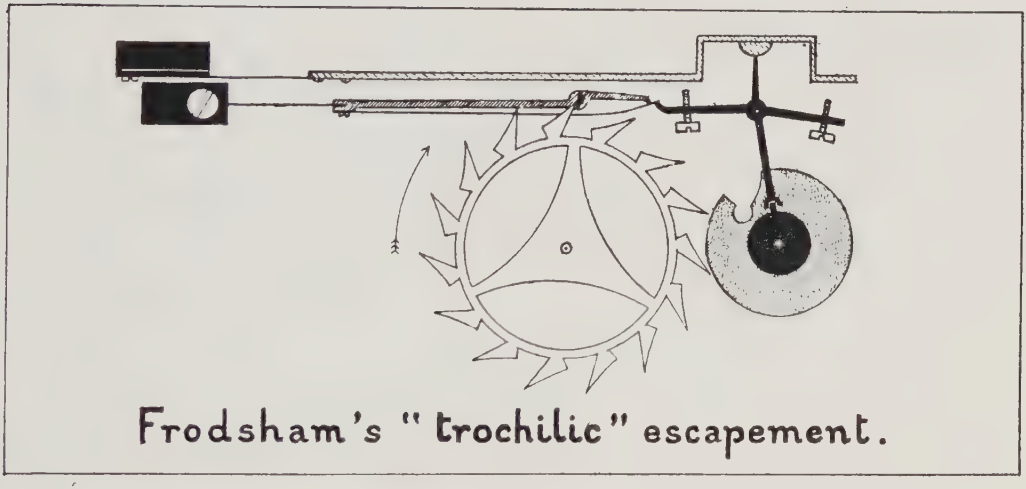
This was invented with the aim of lessening the danger of tripping. It is most ingenious and it avoids the use of an extra intermediate wheel (as compared with Cole's double rotary escapement), see Gould's diagram.

It has a spring detent escapement but unlocking is obtained by the anti-clockwise rotation of the balance which moves the fork of a " T " piece and lifts the passing spring, and then comes to rest against a separate spring detent. After the escape wheel has given impulse to the balance and the balance has completed its excursion, the balance returns in a clockwise direction and picks up the fork of the " T " piece so that the left-hand arm passes the passing spring and is once more back in position. Now supposing the balance has been given an extra twist and that the balance continues to rotate, it will again hit the fork (this time on its outer lip) and the unlocking pallet will only be pulled away from the locking position. In the

same way, if the balance over-rotates after receiving impulse, then the " T " piece will already be beyond the passing spring and will receive a further impulse, again, away from the passing spring, so that, either way, no tripping can occur. (By " tripping ", we mean, unlocking at the wrong time.)

The only record of its use is for 1885 when it was tried in Marine Chronometer No. 3532 at Greenwich and obtained a Trial Number of 31.9.

It is described in the *Horological Journal* on page 43 of the November, 1885, issue, where it is pointed out that in this escapement the balance can revolve an unlimited number of times in the unlocking direction without unlocking more than once, to distinguish it from the double rotary, which only allows a little more than two turns.



Frodsham's " trochilic " escapement.

International Inventions Exhibition, 1885

Frodsham & Co. were awarded a Silver Medal for improvements in non-magnetisable watch balances.

By July, 1893, the Company was in real trouble financially, and we find that Harrison Mill Frodsham was facing proceedings for bankruptcy.

Charles Frodsham & Co. Ltd.

On the 25th July, 1893, the firm was granted a Certificate of

Incorporation as a Limited Company, and the business, which had belonged to Harrison Mill Frodsham, was bought by the new firm. Harrison Mill Frodsham became the Managing Director, with Sophus Emil Nielsen and J. R. Furneaux as Directors. Albert Ernest Rutherford, who appears to have been with the firm since about 1880, had one share, and Albert's sister, Edith Susannah, who had married Harrison Mill before June, 1878, also had one share.

84 Strand

In December, 1894, the firm received a Parliamentary Notice regarding the pulling down of this building, in preparation for " The Cecil Hotel Development Scheme ". This was a blessing in disguise since the Strand was no longer the fashionable shopping centre that it had been, and so new premises were sought.

115 New Bond Street and 11 Duke Street

Bond Street was rapidly becoming famous for the buying and selling of the highest quality goods, so that New Bond Street was an excellent site for their shop which opened in September, 1895. Workshops were rented at 11 Duke Street in 1896 where H. J. Furneaux was employed, whilst Rutherford, Jolly and Cooper were at work at 115 New Bond Street. **Plate 44**, page 386.

S. E. Neilsen ceased to be a Director early in 1898; Rutherford was appointed Manager at £3 per week.

Mystery Clocks, etc.

In about 1899 various unusual clocks were being made, for example " Tortoise Clocks " (the tortoise floats on a bowl of water and points to the time with the aid of a moving magnet), " Fan Clocks " and " Sunflower Clocks ".

Horse Shoe Yard

This was situated just behind 115 New Bond Street. The workshop was removed from Duke Street to a basement in Horse Shoe Yard in 1903.

A. E. Rutherford, Director and Manager

Efforts were made to sell the business at a fair price and eventually Rutherford offered £5,000 cash. This was accepted and he was made a Director and Manager of the Company in 1906.

" Upside Down Clocks "

In 1911 a number of small mantel clocks were made with their movements upside down, i.e., with the platform escapement at the bottom, so that a seconds hand could be placed at the VI position. They became known as " Upside down clocks ". **Plate 48**, page 390.

" Sedan Chair " Clocks

Reproductions of this style of clock were also being made in 1911. As can be seen in the plate they had no seconds dial. They were fitted with Swiss watch movements. **Plate 48**, page 390.

Speedometer and Motor Accessories Department

In 1911 the firm opened up a branch specialising in speedometers at 17 Dering Street, advertising to this effect in various magazines, such as *The Motor*. Dering Street lies just off Oxford Street, and not far from South Molton Street. This branch was maintained until 1916 when the goodwill of this department was disposed of to North & Sons Ltd., the makers of Watford Speedometers and Magnetos, etc., of 14 Soho Square, London, and of Watford. (See also in the chapter dealing with Nicole Nielsen & Co.) **Plates 45 and 46**, pages 387 - 388.

W. Rock

William Rock was born in England, and died at the age of 73, in 1931. Prior to joining Frodshams he had worked in America for the Waltham Watch Company. In 1913 he was the manager in charge of the workshops in Horseshoe Yard, where his speciality was the manufacture of platform escapements. Donald de Carle recalls that the staff found his Americanisms most amusing. *The Horological Journal* for May, 1931, tells us that he became manager to the Bond Street firm and that his special duty was to attend to the 300 or so clocks and watches at Buckingham Palace. He is

believed to have had interviews with Queen Victoria, King Edward VII and the Kaiser. He was said to have invented the speedometer which was purchased by the Dion Co. so that the Dering Street branch might have suited him well. However, the only patent I can find is in the name of J. C. Rock, who obtained a patent for a speedometer in 1904. Perhaps he was a brother ? Owing to the air-raids William went to live in Buckinghamshire, where for ten years he was host of the Mother Red Cap Inn, White Hill, which was the only dwelling he could find vacant.

H. J. Furneaux (son of J. R. Furneaux who had been a Director of the firm since 1893)

In November, 1904, Henry John Furneaux, of 23 Earlsthorpe Road, Sydenham, was granted Patent No. 4189, for a speedometer, but whether this was used by the Dering Street branch is doubtful. However, there is nothing to suggest that he had a hand in the running of the speedometer department. **Plate 49**, page 391.

Rutherford used to leave the South Molton Street premises each morning to go to Dering Street for a short time, so that he must have been largely responsible for the manufacture of the speedometers in addition to his main job as Managing Director of Frodshams.

Donald de Carle

In 1913, having completed his apprenticeship to James Bray, Donald de Carle joined Frodshams at 115 New Bond Street, but in 1918 he left the firm and joined the Goldsmiths & Silversmiths Co. (now Garrard & Co.). He retired in 1969.

27 South Molton Street

In December, 1914, the main business was moved from 115 New Bond Street to 27 South Molton Street.

Inclined Plane Clocks

Reproductions of this type of clock were being sold in about 1920.

Jane Grace North

On October 26th, 1920, A. E. Rutherford sold the majority of his shares in the Company to Mrs. Jane Grace North (the wife of Robert Benson North) who now became virtually the owner of the firm.

Harrison Mill Frodsham's death

He died on the 24th September, 1922, at Southend-on-Sea at the age of 73. In his Will, which he made in 1917 when he was living at Streatham, he said, " I bequeath to my trustees [his wife, Edith Susanna, and her brother, Albert Ernest Rutherford] all that my share vizt one sixth part of my father's residuary estate Upon trust to pay the yearly income thereof to my said wife during her life and after her death the said trust fund shall be paid over to the official trustee in Bankruptcy of 982 of 1984 for distribution among my creditors Everything else I bequeath absolutely to my wife." His effects were valued for probate at £6,561.18.7.

When his wife, Edith Susannah, died in 1928, her effects were valued at £176. They were the last of the Frodshams to be involved in the running of the business.

Robert Benson North

In October, 1922, following the death of J. R. Furneaux and Harrison Mill Frodsham, Robert Benson North (the owner of Watford Speedometers of 14 Soho Square) was appointed Director and Chairman of Charles Frodsham & Co. Ltd.

Albert Ernest Rutherford's death

On February 18th, 1919, he had been granted the Freedom of the City of London, and in the same year he was admitted to the Livery of the Worshipful Company of Clockmakers.

In October, 1923, his salary was raised to £350 per annum, but unfortunately he died on the 23rd October, 1923, at the age of 64. He was born in Cambridge early in 1859, and, as already mentioned, his sister, Edith Susannah Rutherford, had married Harrison Mill Frodsham before 1878, so that it would appear that Albert had joined the firm in about 1880, i.e., soon after this marriage.

According to the Obituary Notice in the *Horological Journal* for December, 1923, Rutherford was a clever horologist and an expert as regards antique specimens of horology; a man of refinement and charm who was connected with many charitable societies and was a keen worker for the Catholic Church, of which he was a member. In November, 1885, he wrote a letter to the *Horological Journal* concerning the Invention of the Compensation Balance, and in October, 1900, he translated an article written by Monsieur Planchon for the *Journal* concerning two clocks driven by falling balls.

After his death, probate of his Will was granted to Eleanor Annie Rutherford, widow. His effects were valued at £58.8.7.

William James North (elder son of R. B. North) was then appointed Director in Rutherford's place, so that R. B. North and W. J. North were now the sole Directors of the firm. They decided to pay all Rutherford's debts. **Plate 65**, page 407.

Magneta Time Systems

On January 25th, 1924, the Company resolved to purchase, from R. B. North, his holdings of Magneta Time Systems Installations, for £701. These installations were in operation at the following places :—

Lambeth Town Hall.
Rumpelmayer Ltd.
City of London Union.
London County Council.
Royal London Ophthalmic Hospital.
Press Printers Ltd.
Page & Pratt Ltd.
J. Carter & Sons Ltd.
St. Paul's Girls' School.
Dawson Bros.
Motor Union Insurance Co.

The last four of the above were still on hire in 1945, and the last one to be dismantled was the one at St. Paul's Girls' School, in 1974.

Royal Warrants

The firm now held three Royal Warrants of Appointments, and these were renewed in 1924, in the name of R. B. North; these were :—

1. His Majesty the King.
2. H.R.H. The Prince of Wales.
3. Her Majesty Queen Alexandra.

Frodshams were, and still are, responsible for the maintenance and winding of all the clocks at Buckingham Palace, where they have their own workshop. The two men at present employed in this work are Michael Vaisey Potter and George S. Hodgson.

Chronometer Clocks

In 1927, Thomas Mercer of St. Albans was making 8-day Chronometer Clocks for Charles Frodsham & Co. Ltd. No. 2459 is illustrated on page 126 of Tony Mercer's book, *Mercer Chronometers*. **Appendix XII**, page 265.

Apprenticeships

It must be appreciated that R. B. North was an excellent watchmaker and so it is not surprising to find that he had two official apprentices.

1. Joseph Widdowson Moss, who was apprenticed to R. B. North on November 11th, 1925, for seven years. £25. " Half being paid from the Henry Dixon Charity for the Drapers Company, the second half being payable at the commencement of the second half of the term provided that the Drapers Company are satisfied that the apprenticeship has been properly carried out. (Cancelled by mutual consent on the 11th November, 1927.) "

2. Arthur Frederick Miles was apprenticed to R. B. North on the 16th February, 1927, for five years. £25. Payable by the Trustees of the United Westminster Almshouses.

Robert Benson North

Born in about 1867, he received his technical training at the British Horological Institute, to which he was elected in 1898. During his training he was awarded several prizes :—

In 1886, he won Mr. Wrights prize, consisting of, " Saunier's Handbook and Grossman's Essay ".

In 1888, second prize, by the National Co-operative Guild for a fine watch with double roller escapement.

In 1889, bronze medal, at the Mid-London Industrial Exhibition, for a finished watch.

In 1892, second prize (£2) and bronze medal, by the City and Guilds London Institute.

In 1898 he held classes at the B.H.I. on " Springing and Timing ", and again on the same subject in 1908 at the Northampton Polytechnic.

In 1907 he was elected to the Council of the B.H.I., serving on this for many years.

He was therefore very well qualified to become Chairman of Frodshams in 1922. As we shall see in the chapter on the firm of Nicole Nielsen, in 1905 North opened a large business, known as " North's Speedometer & Magneto Works " at Watford.

He was full of energy and initiative; he even obtained a Patent in 1903 for a tourbillon. This will be discussed later.

Unfortunately he died on March 20th, 1929. His younger son, also Robert Benson North, was appointed Director and Chairman in place of his father. **Plate 66**, page 407.

J. M. Ellison

Was appointed Director in September, 1931. He had been with the firm since his youth. Chamberlain tells us that, " Mr. Ellison relates a tradition indicating the close friendship of Mr. Frodsham and his workmen. Noticing that an artisan seemed listless in his work, Mr. Frodsham (handing him a pill box filled with gold sovereigns) would say, ' I believe you need a vacation; go to the country and take some of my pills '." Ellison could hardly have known Charles Frodsham, so perhaps this refers to Harrison Mill Frodsham.

In 1939 Ellison approved the purchase of a Stroboscope from R. B. North for £26.9.6. A Stroboscope is described as an apparatus for observing periodic motion by throwing a light at intervals on

the rotating body. One wonders what use it could have been to the firm ?

In June, 1939, Ellison tendered his resignation, and retired in December.

Mrs. Jane Grace North

The principal shareholder, died at Lancing on August 26th, 1939, i.e., just before war was declared on September 3rd.

Bombing

In 1940 27 South Molton Street suffered considerable damage as the result of an air-raid. The business was still being run by R. B. North and his brother, W. J. North.

Philip Arthur Clowes

On July 24th, 1941, Phillip Clowes became a shareholder in the firm. He was then 35, having been born in Sussex and educated at Malvern College. Whilst studying law and languages he became interested in horology and even visited Swiss factories. He also had a talent for acting and joined a repertory company which made a tour of the world. On his return to England in 1934, he went into partnership with another keen amateur horologist, Captain J. Jauncey, R.N., D.S.O. (bar), and the firm of " Clowes & Jauncey " was established at 62 Beauchamp Place, S.W.3, and it was here that other expert horologists such as Courtenay Ilbert, Lord Harris and Malcolm Gardner, used to meet. Jauncey rejoined the navy at the beginning of the war and became Rear-Admiral, Destroyers, in Scotland, but he did not return to the firm after the war.

62 Beauchamp Place

At the meeting on July 24th, 1941, it was pointed out that the Company had made a small loss of £789. It was decided that the lease of 27 South Molton Street should be surrendered, and at the Annual General Meeting the following day it was agreed that the business should be transferred to Beauchamp Place.

Clowes was made a Director, and in January, 1942, he obtained a greater interest in the firm by the purchase of a number of the

shares from R. B. and W. J. North. The Company now acquired the assets and goodwill of Messrs. Clowes & Jauncey. Phillip Clowes, who was in the R.N.V.R., was called to the forces, but in spite of this managed to keep an eye on the business during the war years.

Miss Gladys M. Yule

On June 11th, 1942, she purchased £3,000 worth of Debentures from the two Norths, and Philip Clowes purchased £1,000 worth from R. B. North. Miss Yule was a wealthy friend of Philip Clowes, so that he was now virtually in charge of the firm.

R. B. North retired from the Board in November, 1942. At the same time, Clowes reported that he had purchased 48 antique clocks from a Mr. Hardcastle of Leeds for £3,060, and to do this the Company had had to borrow £2,150, from the following :—

Mr. Ilbert	£900	No interest payable.
Miss G. Yule	£750	At 5% per annum.
Mr. P. A. Clowes	£500	No interest payable.

This was nearly all repaid within 12 months.

During the war years Philip Clowes had spent much time considering the future of Charles Frodsham & Co. Ltd., and in due course he drew up the following plan of action :—

1. Retail

To open a retail shop in a prominent position with the object of creating a modern watch and clock business, incorporating and extending the antique business of Clowes & Jauncey and providing a retail outlet for the products of the manufacturing side of the business.

2. Manufacturing

This he divided into three separate projects :—

a. To commence by making a range of reproduction timepieces in English styles.

b. To proceed from this to the manufacture of really high-grade clocks, regulators and chronometers.

c. To design and manufacture a precision wrist-watch suitable for navigation purposes for use by the armed services. (For this object considerable Government support was likely to be forthcoming.)

173 Brompton Road

By August, 1946, the firm had left Beauchamp Place and had moved to Brompton Road, once the bomb damage to the latter had been repaired.

Trainees

Shortly after the premises at Brompton Road were opened in 1946, Philip Clowes obtained government support for the training of ex-servicemen in clockmaking and repairing.

Six trainees were selected and the scheme must be considered a success since two of them, G. S. Hodgson and M. V. Potter (already mentioned) continued as permanent staff after the training period was over and became fine craftsmen who were destined to play an important part in the future of the Company.

G. S. Hodgson served in the manufacturing department for a short period and then moved to the clock repair workshop, specialising in the finest English and French work. He became foreman in charge of the workshop in 1962 and, on the closure of the retail business in 1977 he joined M. V. Potter on the Royal contract work.

M. V. Potter worked in the clock repair workshop where his ingenuity and ability to undertake a wide range of work were much appreciated. In 1962 he took over the work on the Royal contracts and continues with this at the present time.

C. M. Morgan

Another long-serving member of the staff was C. M. Morgan. He was apprenticed to learn watch repairing at Asprey in Bond Street in 1926 and, when Clowes & Jauncey took over Asprey's watch work shortly before the war, he joined their staff, transferring to Frodsham's when Philip Clowes amalgamated the two companies.

He served as the chief " in house " watch repairer and during the war and in the post-war years he was responsible for much of the special work.

In 1976 the firm presented him with a carriage clock to mark his 50 years in the trade and he retired at the end of that year. Unhappily he did not enjoy a long retirement and died in the autumn of 1979.

A. S. Andrews

After having a splendid training at 14 Soho Square working for Nicole Nielsen & Co. and remaining with the firm until its closure in 1933, Stanley Andrews joined Frodshams and stayed in their employment until 1941. He then went to work for the Goldsmiths and Silversmiths Company, leaving them in 1945 to rejoin Frodshams.

Post-War Development

During the war years the Company had been able to keep their workshops fully occupied with Government contracts, especially the contracts from the Ministry of Aviation. Fortunately, Clowes had been posted to the Admiralty as an instrument expert. He had therefore been able to attend all the Board meetings during the war.

But, of course, all these contracts ceased at the end of the war and Clowes now had the opportunity to develop the idea which he had had in the back of his mind for some time; this was to expand the clock department and commence the actual manufacture of clocks. To do this it was necessary to recruit more staff.

He soon put into operation the manufacture of a large eight-day clock movement. At first they were made individually, but later on he introduced a modified mass-production procedure.

Clock Manufacture

The purpose of making these movements was to give them a variety of cases and, since Clowes was an expert on antiquarian clocks, he decided to use antique styles. He approached Percy Dawson (of the firm of G. J. Dawson), who had been introduced to Clowes in 1935 by John James when the latter was working with Clowes & Jauncey at Beauchamp Place. Percy Dawson had no sooner returned from serving in the Navy on May 26th, 1946, than

a week later Clowes had placed an order with the firm for 12 brass inverted bell-top cases and 100 brass clock cases. The clocks were given a variety of names, most of which refer to the name of the original maker of the clock style in question.

The Princess

So called because the first of these 12 gilt-brass cases with inverted bell-tops to be made was presented by the firm to H.R.H. Princess Elizabeth on the occasion of her marriage on November 20th, 1947. Hence the clock's name. The movement for this was entirely made by C. Morgan. The design of this clock is similar to the Richard Peckover shown in the Hurcombe catalogue of the Weatherfield collection.

In 1949 the gilt-metal version sold for £40. Six wooden cases of the same design were ordered on August 28th, 1946, and these were sold for £23 or £26. **Plate 53**, page 396.

The Viennese

This style was popular in Vienna during the first half of the 18th century. This was the design of the 100 brass cases mentioned above. These were sold for £32 in 1949, when they were offered to E. Dent & Co. Ltd. at the wholesale price of £18. **Plate 53**, page 396.

The McCabe

Twelve wooden cases were ordered from Percy Dawson on November 18th, 1946. These clocks were sold at the retail price of £32. **Plate 52**, page 395.

The Tregent

Twelve wooden cases were ordered on December 30th, 1946. These sold for £45. **Plate 50**, page 392.

The Markham

Six cases were ordered on December 30th, 1946. This was a replica of the one in the Royal Collection at Buckingham Palace. Price £110. **Plate 50**, page 392.

The Tompion

Twelve cases were ordered on March 3rd, 1947. These sold for £30, £31 or £32, the latter having both escutcheons and top appliqué. **Plate 50**, page 392 - 393.

The Colley

Twelve mahogany cases were ordered on March 3rd, 1947. These sold for £44. **Plate 50**, page 392.

The Frodsham

Basically the same as the Colley, but having a walnut case and wooden frets. **Plate 53**, page 396.

The Cumming

Twelve cases were ordered on March 17th, 1947. Silvered dial £49. Mounted dial £53. **Plate 51**, page 394.

The Chippendale

Twelve cases were ordered on March 20th, 1947. Selling at £40. **Plate 53**, page 396.

The Sedan

Fifty small hanging cases were ordered on May 15th, 1947. This, however, did not have a Frodsham movement. A quantity of ex-R.A.F. aircraft clocks had been purchased. New dials were fitted to these movements which were then put into these cases to make a cheap wall clock which could be marketed quickly whilst other clocks were in short supply. **Plate 48**, page 390.

The Cole

A silver case was ordered on July 15th, 1947, for which the designing was done and all the casting patterns were made by Percy Dawson's firm, although the actual silver work was done elsewhere. The movement was made by Phillip Thornton; it had a perpetual calendar, showed the phases of the moon and was constructed with a fusee and maintaining power. Apparently only one was made. This was bought by the Mothers' Union and presented by them to

H.M. the Queen on the occasion of her Silver Wedding on April 26th, 1948. In February, 1949, or thereabouts, Phillip Thornton was given an order for a number of these movements (perhaps as many as a gross), by Frodshams, and Percy Dawson made a dozen wooden cases. This had entailed the making of a very elaborate jig in order to bend the wood to shape. However, there was apparently some dispute between Clowes and Thornton, perhaps in connection with the price, and no more movements were made. Clowes refused to accept delivery of the cases and refused to pay for them. In spite of this the orders for repeats continued until 1950, especially for the Princess, but by 1948 Clowes was employing another firm to make mass-production cases, and by October, 1948, Dawsons were decorating the mass-produced cases, having supplied Princess handles since March, 1948. **Plate 51**, page 394.

The Peckover

This was another gilt metal bracket clock, but rather more expensive, £90. **Plate 53**, page 396.

The Murray

An elegant wooden case. Selling at £45 or £49, depending on the mounting. **Plate 51**, page 394.

The Ellicott

A wooden case bracket clock, costing either £28 or £32. **Plate 52**, page 395.

The Emery

Wooden case. (Wooden cases could be either mahogany or walnut for most clocks.) Costing £37. **Plate 52**, page 395.

The Grant

There were three designs for the Grant, costing £20, £26 and £44. **Plate 52**, page 395.

The Breguet

The case was modelled on " The Breguet Synchroniser " in the

Royal Collection. It was supplied with a special movement, having an eight-day fusee mechanism with chronometer escapement. It was offered at £290. **Plate 51**, page 394.

The Gould

This was a grandmother clock, 5′ 6″ high, with a walnut case having marquetry inlay, it was given a Frodsham Domestic Regulator movement, with dead-beat escapement and compensated pendulum. Costing £370. **Plate 53**, page 396.

The Quare

A grandmother clock in plain walnut case, 5′ 4″ high. Movement similar to the Gould. Costing £300. **Plate 53**, page 396.

Of all these, it would appear that the Colley, Markham, Cumming, Murray, Emery, Chippendale, Peckover, Viennese, Breguet, Cole, Gould and the Quare were never repeated after the first order.

The Colley, Markham, Cole, Princess, Chippendale and the Breguet were all detailed reproductions of particular cases. The Princess was, however, redesigned for mass production.

The firm of G. J. Dawson had been employed, in one way or another, by Frodshams since the early twenties, so that it was indeed sad to find that, following the incident concerning the Cole cases, the relationship between Clowes and Percy Dawson had changed from close friendship to icy coldness and eventually ceased altogether. Incidentally, it was largely through Clowes that Percy Dawson had joined the Navy. It must be appreciated that all the original cases for the post-war range of Frodsham clocks were designed and made by Percy Dawson. It was therefore entirely due to his expertise that such an attractive range of clocks was produced. Their proportions and appearance were superior to any clocks of this type which have been produced before or since that time.

Movements

The first movement manufactured was an eight-day one, $4\frac{1}{4}'' \times 3\frac{1}{4}'' \times 1\frac{3}{8}''$, the "A" size. In 1949 a smaller eight-day movement was being mass-produced, it was $2\frac{3}{4}'' \times 2\frac{1}{2}'' \times \frac{5}{16}''$, and was known as the " B " movement or the " Princess movement ", since it was

used in the smaller reproduction cases such as the modified "Princess". An eight-day striking movement was in the process of development in 1949. **Plate 54**, page 397.

In 1947 Clowes sold ten Preference shares to Major Hugh Rose Swire Frodsham, a grandson of Charles Frodsham, and in the same year Clowes made a gift to the Company of £3,000. Major Frodsham died in 1950. In January, 1948, Malcolm Gardner, of 12 Earnshaw Street, was appointed Director in place of R. E. Heath who had resigned. W. French was appointed Works Manager.

Bank Loan

In March, 1948, it was obvious that much more capital was needed for the massproduction of these clock movements. The Bank was willing to lend up to £3,000, but this was not considered enough, so Miss Yule stepped into the breach and agreed to provide the necessary cover to enable the firm to borrow up to £12,500.

Miss Gladys Yule was the daughter of Sir David Yule of the firm of "Yule, Catto & Co. Ltd.", East India Merchants. Lady Yule was a great friend of the mother of Philip Clowes, and this is how Gladys and Philip became friends.

Import Duties

In October, 1949, when sterling had been devalued, it was realised that, under the U.S.A. Tariff Laws, watches, whose movements were less than 1.77″ in width, were subject to a lower import duty than for clocks. So, in common with other English manufacturers, Frodshams planned to take advantage of this by merely re-arranging the wheel train of the Princess movement in order to have narrower plates; a comparatively simple matter. The measurements of the Miniature Princess movement were: Height $3\frac{1}{8}$″, width $1\frac{3}{4}$″, depth between plates $\frac{3}{4}$″ and overall depth $1\frac{5}{8}$″, which allowed them to be imported into the U.S.A. under their watch tariff.

(But Mr. Thirkell says that there was much wishful thinking in regard to the American market, and he cannot recall that any of these narrower movements were actually sent to the U.S.A.)

Frank Leslie Thirkell

From his early years he had been so keenly interested in clocks

and watches that he was determined to make horology his career. In 1931, at the height of the great depression, he was due to leave school. There could hardly have been a more difficult time to enter such a trade. He therefore stayed on at school for a further two years, and then in October, 1933, he was fortunate enough to obtain a position at Mappin & Webb in Regent Street, where they had an excellent watch and clock department. In this way he gained good experience in the business side of the trade whilst his spare time was spent studying practical work.

In 1939 he was transferred to Mappin & Webb's Oxford Street branch, and in 1940 he joined the Royal Air Force as an instrument repairer.

He was demobilised in 1945 and returned to Mappin & Webb, but then, feeling somewhat unsettled, he became anxious to find employment with a firm specialising in horology.

He had met Malcolm Gardner in 1936 when buying books from him and after the war he often visited the Earnshaw Street shop. In the middle of 1946 Malcolm Gardner introduced him to Philip Clowes and eventually it was agreed that Thirkell should join Charles Frodsham & Co. Ltd. at the beginning of 1947 to manage and develop the retail side of the business in the recently opened premises at 173 Brompton Road. Here he found an exciting horological atmosphere which was enhanced by the privilege of meeting the leading collectors of the day such as Lord Harris, Sir John Prestige and Courtenay Ilbert, and he was stimulated by the endless discussions with such varied characters as Malcolm Gardner, Andrew Fell and Major Cowen. This was all experience which was to stand him in good stead when in later years he became deeply involved in the management of the Company. **Plate 70**, page 410.

Philip Thornton

W. H. French had been made a Director in 1949, and Frank Leslie Thirkell (who had joined the firm on January 1st, 1947) was in need of extra assistance owing to the development of the retail side of the business. In spite of the disagreements between Clowes and Percy Dawson and also Philip Thornton, the firm was very busy. Malcolm Gardner, having been told that Thornton had not

been paid for the work he had done, brought the matter up at the Board Meeting on October 5th, 1949. He was informed that, in fact, the Company considered that Thornton was in debt to them. To try to settle the matter, a visit to Thorntons was planned to find out how many of the calendar clocks were sufficiently advanced to make it worthwhile for the Company to take them over as part of the terms of a general settlement. Philip Thornton was highly regarded by all at Frodshams and the situation was greatly regretted.

This was a classic example of a situation which readily arises in clock manufacture between the main producer and a sub-contractor, where both under-estimate the problems of production — the sub-contractor needs more finance, and the manufacturer complains that he has not received results for the finance already provided.

French and Thirkell visited Philip Thornton at Great Haywood in about 1953 to make one more attempt to resolve the matter, but, although friendly relations were re-established, they were unable to make any business arrangements with the limited resources then at their disposal after Philip Clowes' death.

Mass-produced Clock Cases

K. H. Graham & Co. had been employed by the Company until the former suffered a fire. Martyns of Cheltenham then made a number of Princess cases.

Watch Manufacture

In the late forties two patterns of "Frodsham" watches were produced as forerunners to the production of a completely new design of watch which was planned for the future.

Among the old Frodsham stock were a number of unfinished ¾-plate lever movements. These were completed by A. S. Andrews and fitted to silver cases made by Oliver. One such watch is :—

No. 10092. It is signed *Chas. Frodsham, Brompton Rd. London. AD Fmsz. By Appt. to the King.* It is a keyless watch with going barrel and has an engine-turned silver dial. Hall mark, London, 1947. Case maker "ATO", i.e., for Oliver.

Two others are known, they are Nos. 6979 and 9932. They also

have the hall-mark for 1947, and have superb engine-turned dials similar to No. 10092.

No. 9932 has a club tooth escape wheel and No. 10092 has a ratchet tooth wheel.

It seems probable that these widely differing numbers must have been the original ébauche numbers.

The other pattern was for a wrist-watch. To produce this, 100 sets of parts were ordered from Smiths. These were basically the same as the ones used in the 12 ligne Smith movement of the period, but having minor alterations to the plates. These movements were assembled at Brompton Road where the springing and adjusting was also undertaken. The movements were fitted into stainless steel cases specially made by Dennison. The dials were based on 19th century designs with plain Roman or Arabic figures. A small disc, bearing the name " Frodsham, London ", was screwed to the back plate of each of these watches.

Micron Instruments, 1950

Andrew Fell of the National School of Horology had been advising the Company with regard to the making of a 12 ligne precision watch. Should the scheme go forward, it was said, finance to the extent of £90/£120,000 would be required.

Four weeks later the Treasury had agreed to bear the cost of the necessary plant up to £35,000, and Miss Gladys Yule, of Hanstead House, Bricket Wood, Herts., said she would be willing to be responsible for the manufacture of the Company's clocks and watches under the guidance of technical experts. It was agreed that in due course Andrew Fell would join Frodshams to become Technical Director of Micron Instruments.

Premises had to be found for the manufacture of these precision watches and it was proposed that Park House, Gosport, should be purchased for the purpose of housing the Crown Plant, and that the Company should make an offer up to £3,250. Malcolm Gardner said : " Personally, as a Director, I am not in favour of the manufacture of the watch . . . as a businessman, I would never have embarked on it, and as a private investor I would not have put a farthing in it ". Nevertheless, in spite of Malcolm Gardner's fore-

bodings, it was agreed that the Gosport property should be leased to Miss Gladys Yule, trading as " Micron Instruments ".

Death of Philip Arthur Clowes

He died on June 26th, 1951, at the age of 45, still unmarried. His death was indeed a severe blow to the firm into which he had put new life. It is said that at the time of his death the firm was producing 1,000 movements a year.

In the five years after his demobilisation in 1946 he had achieved his main objective, i.e., the opening of a splendid shop in Brompton Road in August, 1946, and, as regards manufacturing he had succeeded admirably in producing a splendid range of replicas. He had begun the production of high-grade clocks and he was just about to commence the making of a precision watch.

Within days of his death the firm was missing Philip Clowes' drive, and Miss Yule no longer wished to proceed with the watch project. **Plate 67**, page 407.

Malcolm Gardner was now made Chairman, Gordon Stephens became Managing Director, Thirkell was made Shop Manager, with W. A. Kermock as Clock Repair Manager and William Herbert French as Works Manager.

William Alfred Kermock

His grandfather, William Kermock, had been a master clockmaker in Clerkenwell, and this may well have encouraged W. A. Kermock to become apprenticed at the age of 22 to E. J. Morrison at 27 Packington Street, Islington. Both Morrison and Morrison's father were noted for the clocks they made, many of which were supplied to Frodshams and to Dents. At the end of his apprenticeship, in 1926, Mr. Kermock joined Frodshams. At this time there were two outstandingly good watchmakers in the firm, one was Robert Burrett (his father had worked for Frodshams at 84 Strand and at New Bond Street), he was a splendid workman and quite a " character "; the other was a Dane by the name of Fred Larsen who was an excellent watchmaker and a wonderful salesman, with a fantastic memory so that he could almost always remember a customer's name even if he had not been seen for years. Then

there were the outside workers such as the brothers Alfred and Will Curzon, the former worked at 312 St. John's Street, and was the maker of model escapements for the Northampton Polytechnic.

As to W. A. Kermock, after a few years he had become so proficient that he was sent to assist Mr. Bowman, who was in charge of the clocks at Buckingham Palace, and after about five years Mr. Kermock was put in charge, so that he visited the Palace for about 30 years in all until his retirement in 1962. He had worked for Frodshams all this time except for a break of about six months when he was employed by Clowes & Jauncey in 1942 until Clowes took charge of Frodshams.

" Princess "

Messrs. Smiths English Clocks were asked to abandon the use of the name " Princess " on an alarm clock, since the name was a Trade Mark belonging to Charles Frodsham & Co. Ltd.

The Trade Sign

Outside the premises at 173 Brompton Road there used to be an 18th century figure (about four feet high) of a sailor using a sextant. Although this little statue had, in fact, no historical connection with the original firm of Charles Frodsham, nevertheless it was used as a " Trade Sign " and was depicted in all the firm's catalogues which were issued during the Brompton Road period. How did it come to be there ? Shortly after the Second World War, Clowes and Jauncey happened to be driving through Leith (Edinburgh), when they noticed this statuette attached to a wall. Clowes acquired the figure and together they removed it from the wall and carried it away in Clowes' car. It remained outside the shop at Brompton Road for about 25 years and then, when the premises closed down in 1973, it was sold. **Plate 64**, page 406.

There are, I gather, several similar figures in existence, one being in America, another in the museum at Edinburgh and a third was, I believe, offered for sale recently for about £4,500.

Festival of Britain, 1951 Ship's Bell Clock

Frodshams were entrusted with the upkeep of antiquarian clocks

at the Festival. In the report in the *Horological Journal* for July, 1951, there is a description of a unique clock of which Philip Clowes was particularly proud. Unfortunately, it could not be seen by the general public, as it was the Eight Bells clock made for the King and placed in the Royal Pavilion. It had a beautifully finished movement, and was completely covered by a glass "Ship's Bell", on which the series of bells for hours and half-hours were struck, including dog watches, which involved using a 24-hour wheel. The glass, which gave a clear bell-like note, being suspended from the top of the movement and, of course, it had to be removed to rewind the clock. W. H. French designed the clock in collaboration with Mr. Wells-Coates, O.B.E., R.D.I., who was president elect of the Faculty of Royal Designers for Industry. **Plate 55**, page 398.

"The Hour Glass"

This was the name given to a small desk clock, which had been made for the Queen, again by Frodshams in collaboration with Wells-Coates.

The "Breguet" Ship's Bell Carriage Clock

In 1955 W. H. French had designed another clock very similar to the one placed in the Royal Pavilion at the Festival of Britain (already described), but mounted in a Breguet style case, as used in the post-war series.

Only one hammer was used to strike the two blows to sound the bells, the lifting pins being arranged in pairs and spaced to give the correct intervals between blows. On the last tooth of the rack being gathered a small locking device is released, allowing a lever to fall down. The last blow at the half-hour is arrested by this lever, a pin on the cannon wheel putting pressure on a light spring attached to the lever. The lever remains in this position until the hammer is once more lifted, when the weighted arm replaces the lever to its normal position.

Basle Fair, 1952

Courtenay Ilbert was asked to attend the Fair as the Company's representative; his expenses up to £35 to be re-imbursed.

Vulliamy's Work Bench

This had been purchased by the Company from Mr. H. Carter who had been given the bench by the firm of Jump. In 1952 an offer was made to purchase it, but it was agreed that under no circumstances should it be sold. Where is it now? It is probably the work-desk belonging to the late S. Benson-Beevers which was mentioned in *Antiquarian Horology*, March, 1957.

H. Carter had worked for Joseph and Henry Jump and had been given the bench when they closed down shortly before 1939. Carter then joined Clowes & Jauncey and later played an important part in the running of Frodshams, during the war years, from 1942 onwards.

Mk. 7 and Mk. 11

In 1952 Frank Thirkell, who was now General Manager, reported that the Mk. 7 and Mk. 11 contracts for the Ministry of Supply were very satisfactory. These contracts referred to the overhaul of watches of various makes which the Department of Navigation sent to Frodshams for this purpose. Unfortunately, this very satisfactory contract terminated in September, 1953, in spite of efforts made by Frank Thirkell to try to persuade G. W. Rickett to give them a further contract.

Camera Timing Cyclometer Clock

The Admiralty Research Laboratory approached the firm regarding the development of a Cyclometer Clock in September, 1952. The Company's Patent Agents advised the application for a Provisional Patent, and the following January the Admiralty asked that Mr. Dixon's name should be included in the application.

By 1954 W. H. French had designed a highly specialised cyclometer clock for the Admiralty. It was to be applied to ciné cameras. The object was to give a miniature record, on the border of each frame, showing the time at which the photograph was taken. This is described in the *Horological Journal* for January, 1954, page 32. **Plate 56**, page 399.

Miss Mollie Clowes

In July, 1953, Miss Yule assigned Preference Shares to the value

of £7,500 to Miss Mollie Clowes (Phillip Clowes' sister), so that she now became the majority share-holder, and was elected a Director. The Company still had a £5,000 overdraft which the bank agreed to retain against Miss Yule's guarantee for twelve months.

Miss Gladys Meryl Yule

It will have been noticed that Miss Yule had been a great financial asset to the firm. It has been mentioned that Gladys was a wealthy young lady. Her father, Sir David Yule, was a millionaire, and when he died in 1928 his assets in England alone were estimated at £348,038 quite apart from his business in India. When his wife, Dame Annie Henrietta Yule, died in 1950 she left her small fortune of £523,198 to her daughter, Gladys. However, when Gladys herself died in 1957 at the age of 53 her effects were valued at over four million pounds so that she could well have afforded to invest some of her money in the firm of Charles Frodsham and Co. Ltd.

Dame Annie Henrietta Yule was always known as " Lady Yule ", but in Sir David's Will and in her own Will she is given the title of " Dame ".

The Princess Striking Movement

In April, 1954, this was ready for production. All the previous movements had been ordinary timepieces. **Plate 54**, page 397.

E. Dent & Co. Ltd.

As early as January, 1948, Daniel Edward Buckney and his son, Daniel Patrick, approached Frodshams, at first with a view to purchasing the assets. Then in April, 1949, the amalgamation of the manufacturing side of the business with that of Dent was discussed. The matter was brought up again in August, 1954, when the Board agreed that an amalgamation of the two firms was desirable. However, after several more meetings and discussions, Mr. Buckney wrote, on March 1st, 1955, to say that Dent's were unable to proceed with the negotiations and that the matter must be abandoned.

Arthur Cover

In October, 1955, the Company was seriously considering the

advisability of amalgamating with some other firm. Miss Clowes once again approached Dents, with a new offer, but, after due consideration, this was again declined, and so the following firms were approached, but none of them were interested :—

Mr. Holman, of Maples.
Lord Keyes and Mr. Oppenheimer, of Mappin & Webb.
Messrs. Cope & Co.
Mr. Barrett, of Smiths.
Messrs. Aspreys.

In July, 1956, Frodshams answered the following advertisement in the *Horological Journal* :—

WANTED TO PURCHASE. First-class Watch and Jewellery Business in main London (preferably West End) thoroughfare. Alternative area considered if good business. Box 805.

Mr. Arthur Cover, a Midlands Industrialist, who had inserted the advertisement, wasted no time, and, three weeks later, he stated that he wished to acquire control of the Company.

By October 1st, 1956, Molly Clowes and Malcolm Gardner had sold their shares to Arthur Cover, and had resigned as Directors.

Arthur Cover and Alan Desmond Cover were elected Directors; S. G. Stephens and W. H. French being the only other remaining Directors. In May, 1957, Mr. Thirkell was appointed a Director, and in June, 1958, he and A. D. Cover became joint Managing Directors.

Alan Desmond Cover

He had been interested in horology as a boy and, on leaving school, he joined a Manchester firm to learn watch repairing. After this he worked as a salesman with the firm of Lawrences, jewellers of Dublin, for about five years. He attended a course at the Horological School at Solothurn in Switzerland. In addition to this he gained commercial experience by working for his father, Arthur Cover, in his textile firm in Manchester and London.

No doubt this was the reason why Arthur Cover wished to acquire control of Frodshams.

Malcolm Gardner

Known to his friends as " Plum ", he was born on the 15th March, 1896. He inherited a splendid horological library from his father, Robert Gardner. Shortly after his father's death he was advised by Courtenay Ilbert to open a shop using the library as his stock. In 1934 he took this advice and opened premises at No. 3 Arthur Street. When the question of new names for certain streets was raised by the Holborn Borough Council, Malcolm Gardner suggested that Arthur Street should be changed to Earnshaw Street since Earnshaw is buried in the neighbouring graveyard of St. Giles, and this was accepted by the Council.

Why was he known as " Plum " ? Charles Allix has been kind enough to tell me the reason. Malcolm Gardner, Ilbert and Jauncey used to visit Paris and on one occasion Malcolm took with him a Breguet watch which he had repaired. Naturally the three of them went to call on the House of Breguet and in due course the watch was shown to George Brown who examined the watch carefully. After a moment he said " a plum-ber has been at this watch "! And this is how Malcolm Gardner came to be known to his intimate friends as " Plum ".

He was fluent in French and in Spanish and was probably responsible for the translation of the Spanish pamphlet as given in Chapter VIII.

He became a Director of Frodshams in 1948, and was made Chairman in July, 1951, retaining this responsibility until October, 1956. He died only a few years later, on the 18th May, 1960.

Manufacturing Department, W. H. French

When W. H. French (who had been in charge of this department since January, 1948) resigned as Production Manager and as a Director in October, 1957, it was decided that this department should close down on the 31st December, 1957.

Mr. French was apprenticed to E. T. Cottingham, F.R.A.S., in

about 1910. He then spent 32 years in the Navy before returning to horology by joining Frodshams.

31 and 33 Palmer Street, S.W.1

The Company obtained a lease on these premises which they opened as a branch on December 2nd, 1957. The firm continued to use these premises until September, 1962. On May 2nd this shop had been the object of a " smash and grab " raid and had lost goods to the value of £750.

173 Brompton Road

The lease on these premises was due to expire in 1958, and so, towards the end of 1956, the Company opened negotiations with the freeholder, a Mr. Till, with a view to acquiring the freehold for which they, at first, offered £22,500. This offer was in due course raised and discussions were at an advanced stage, with the prospect of a final agreement in sight, when Mr. Till died. It did not prove possible to reopen these negotiations with the new freeholder.

In June, 1958, a new 42-years' lease was obtained which, however, gave the landlords the right to terminate the lease after 14 years, but only for the purpose of the redevelopment of the site. Another clause in the lease stated that in the event of the disposal of the freehold it must first be offered to Frodshams at the change of freeholder.

On the first occasion that the freehold changed hands this option had, in fact, been offered to the Company who were unable to proceed at the time, but they were advised by their solicitors that this last clause would operate at any subsequent disposal. This advice, as we shall see, was incorrect.

In March, 1959, extensive alterations were made to the premises including a new shop-front with six display windows. The workshops and offices were re-arranged, and the basement was fitted as a showroom to be used exclusively for the display of antique clocks. Dame Alicia Markova performed the official opening ceremony on October 6th, 1959. **Plates 68 - 70**, pages 408 - 410.

The retail business then developed successfully under the joint direction of A. D. Cover and F. L. Thirkell, and the sale of both

antique and modern clocks and watches improved greatly. An interesting feature of the 1960s was the Company's success in promoting the sale of the electronic tuning-fork watch, the Bulova Accutron, thus continuing the policy of always providing the best timekeeping instruments available.

In January, 1972, it was discovered that the premises had been sold to Trusthurst Ltd. without giving Frodshams first refusal. The Company's solicitors issued a writ against Lord Morris, the previous freeholder, but the action failed and the Company was given notice to quit in December, 1972. Trusthurst Ltd. agreed to give the firm £24,610 on their vacating the premises by July 1st, 1973.

In June, 1973, temporary offices were obtained at 38 Goodge Street, and the stock was put in store.

A proposed acquisition of the firm by Fine Art Metalwork Ltd. did not take place; however, on March 29th, 1974, Paul Frederick Trimming agreed to acquire the total issued share capital.

45 South Audley Street

In September, 1974, a shop had been opened here by Frodshams for the sale of reproduction clocks made by Lake Engineering, of Newhaven.

Devon Instruments Ltd.

In 1976 E. J. Mercer of Devon Instruments Ltd. acquired control of Frodshams, which, in due course, became a fully owned subsidiary of Devon Instruments Ltd.

In January, 1977, the shop at 45 South Audley Street was closed for retail business. However, the shop was reopened in July, 1977, for the sale of reproduction carriage clocks, etc., made by Devon Instruments Ltd.

The firm of Devon Instruments Ltd. was formed in 1946 to develop a commercial side to the traditional clockmaking and repairing training given to disabled persons at St. Loye's College, Exeter. This college was founded by Dame Georgianna Buller (daughter of General Redvers Buller of South African War fame) in the 1930's as a centre for training and re-habilitating disabled

people to assist them in taking up useful employment and a fuller life in the commercial and industrial world. The first Board minutes show that the board included D. H. Amory, Esq., later to become Chancellor of the Exchequer and now Lord Amory. Dame Georgianna was the first Chairman, and was succeeded in 1954 by William Hamilton Shortt, the inventor of the Shortt Free Pendulum clock in 1922.

Production of industrial timing mechanisms, all based on spring drives, commenced during 1947 and many thousands were produced for the marine and aircraft industries. Perhaps their most notable products were those used in space exploration at the one extreme, and at the bottom of oil wells at the other.

Following the retirement of W. H. Shortt in 1965, control of the Company passed to E. J. Mercer who widened the scope of the Company's products with the manufacture of complete marine clocks and reproductions of early carriage clocks. By 1970, the emphasis of the activity was on high quality clocks based on traditional English manufacturers of the 19th century. A natural development of this product line was the acquisition of Charles Frodsham and Co. Ltd. in 1976 which had embodied the same emphasis on quality clocks at that period. The main manufacturing sections are at Topsham, Exeter, where the complete clocks (with the exception of the high quality Swiss escapements) are made. These clocks are marketed throughout the world. Some 86 people are employed, including many of the original trainees from St. Loye's College, with which strong links are still maintained, and a high proportion of disabled persons is included in this strength.

The current range of 16 clocks are all in the traditional English patterns. In recent years several special editions in sterling silver have been produced marking such events as the Silver Jubilee of H.M. Queen Elizabeth, and, currently (1980) the 80th birthday of H.M. Queen Elizabeth the Queen Mother. The basic policy of the Company is still to maintain that of Charles Frodsham himself —the production of high quality, spring-driven clocks conforming to the best traditional English styles. **Plates 105 and 106**, pages 434 - 435.

Manufacturing

Of all the firms engaged in the manufacture of watches for Charles Frodsham & Co. Ltd., the most famous was Nicole Nielsen & Co. This firm will be discussed in the next chapter, and then the following chapter will be devoted to a description of some of the types of watches sold by Charles Frodsham & Co. Ltd.

CHAPTER XI

NICOLE NIELSEN & CO.

This firm of watchmakers was responsible for the manufacture of watches of especially good quality, including the making of complicated movements of all kinds. At first they were renowned for their keyless work and for their chronographs, and then later on the firm began to make pocket chronometers and this lead to the manufacture of superb karrusels and tourbillons. The origin of the firm is as follows :—

Nicole & Capt

The firm of Nicole & Capt was probably founded in 1837 at Geneva.

Nicole & Capt, 80B Dean Street, Soho

In 1840, **Adolphe Nicole**, in partnership with **Henry Capt** of Geneva, opened a business in London at 80B Dean Street, Soho, where the firm stayed until 1858. During this period Adolphe Nicole obtained his first patent.

Patent No. 10,348, A.D. 1844

This is fully described in *Edward John Dent*, pages 275 - 279. It covers Nicole's famous keyless work and a form of chronograph.

In 1843 **Jules Capt** had taken Henry's place.

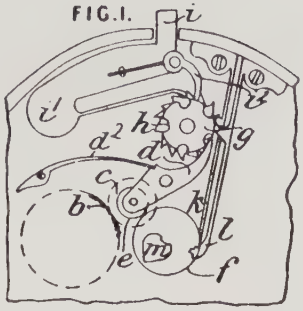
Nicole & Capt, 14 Soho Square

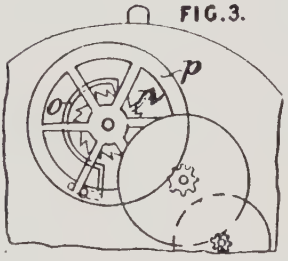
In 1858 the firm moved from Dean Street to 14 Soho Square, i.e., just round the corner. This was in order to obtain larger premises for the business which was already expanding rapidly. For the next 75 years this was to be the address of the business although, as we shall see, the title of the firm changed at times.

Adolphe Nicole now obtained two more patents.

Patent No. 1461, A.D. 1862

This covered a chronograph stop mechanism for starting, stopping, and returning the centre seconds hand to zero.



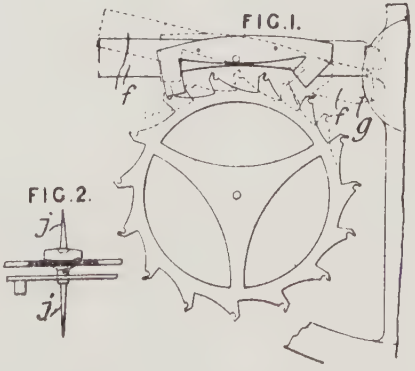


When the push-piece *i* is first depressed, a notch in the disc *g* allows the lever *d* to be returned by a spring d^2, so that a fine toothed wheel *e* carried by the lever gears with the central wheel *f*; the wheel *e* is always in gear by another wheel *c* with a wheel *b* on the arbor of the ordinary seconds hand, and the central seconds hand is thus driven.

On the second depression of the push-piece *i*, the wheel *e* is disengaged from the wheel *f*, and the notched disc *g* drops the spring *k* on the wheel *f* to stop it. A third depression of the push-piece *i* raises the spring *k* from the wheel *f*, and drops the end of the spring *l* on a notched heart cam *m*, on the arbor of the central seconds hand, to return this to zero.

Patent No. 905, A.D. 1870

This describes a resilient lever escapement reminiscent of the J. F. Cole variety. The escape-wheel has recessed teeth so that the pallets can bank on the recess. But if the balance is over rotated, then as the balance passes the notch *g* for the second time the wheel is pushed back and the lever *f* is able to move past its bankings and can restore its position on a later passing. See Gazeley, *Clock & Watch Escapements*, page 190.



Nicole Nielsen & Co., 14 Soho Square

In 1876 **Sophus Emil Nielsen** took the place of Jules Capt shortly after the latter's death. Emil Nielsen (as he was known) had been employed as one of Nicole's workmen and had married Nicole's daughter.

Emil Nielsen was also of an inventive mind and he too obtained a patent :—

Patent No. 13,336, A.D. 1884

This covers the use of an " Up and Down " mechanism.

For twelve years Adolphe Nicole and Emil Nielsen continued to run the business and then, on August 28th, 1888, the firm was purchased by a Mr. North (? R.B.) from Sophus Emil Nielsen; the date of purchase being back-dated to January 1st, 1888. (This suggests that Adolphe Nicole had died and that Emil Nielsen was in sole charge of the business.) S. E. Nielsen received £6,000 in shares and the payment of £3,951 existing liabilities, and was appointed joint Managing Director for five years at a salary of £450 per annum. At the same time, Harrison Mill Frodsham was also appointed joint Managing Director for a consideration of £2,000 in shares. This was not surprising when one remembers that Charles Frodsham & Co. were one of Nicole Nielsen's best customers.

Nicole Nielsen & Co. Ltd.

In May, 1888, the firm was accepted as a Limited Company of Watchmakers. Their factory is described in the *Horological Journal* for June, 1889, page 145.

Factory in Soho Square

Owing to the fact that timekeepers were made for a number of different shopkeepers, all of whom wanted their wares to be as distinct in style as possible, it was very difficult to ensure economy of production by duplicating parts of watches. This did not deter the firm who took pride in the manufacture of all varieties of complicated watches. Unlike a modern factory, the workshops did not follow one another in a regular order.

In the basement the Otto gas-engine for driving the shafting was situated, and also the heavy press for stamping out the plates, etc. For stampings of irregular outline two dies were used, the lower one a trifle smaller than the upper one, so that the punch first pressed a piece from the sheet and then pushed this piece through the smaller die, thereby leaving a smooth surface so that milling could be dispensed with.

On the ground floor there were the special tools for barrel-making, drilling and sinking movements. In all the machine departments there was a driving shaft, running at the back of each bench, making 500 revolutions per minute, and carried in standards rising about 11 inches above the bench. This shaft connected with the various tools by means of friction clutches.

The lathes could be fitted with a chuck having pins on its face to coincide with the dial feet holes. This simplified the placing of the sinks and the one hundred operations which the plates had to undergo. The plate was freed from the chuck face by turning a lever which made three other pins (which were level with the plate), push the plate equally from behind, so that the three fixed pins on the chuck face were not bent.

Milling tools were used in shaping steel parts of irregular form.

On the first floor, machine polishing was performed.

Case-making was also undertaken, so that the firm could make a complete watch, with the exception, perhaps, of the dial.

Robert Benson North

In March, 1898, R. B. North, aged 31, was appointed Director and also as Manager at £250 per annum, and in 1900 he was elected Chairman of Directors, becoming Managing Director in June of the same year at a salary of £450 per annum. In October, 1910, he was elected Life Governing Director, having his remuneration increased to £1,000 in February, 1911.

Tourbillon Carriage Clocks

In 1903 R. B. North had applied for a Patent for " Improvements in Revolving Escapements for Watches and other Portable

Timekeepers ". Patent No. 6737. The words " other portable time-keepers " suggest that already in 1903 he was contemplating the application of a tourbillon to a carriage clock, which could explain the production by the firm, in 1914, of seven superb tourbillon carriage clocks having grand sonnerie striking. See *Carriage Clocks*, page 293. One wonders why a carriage clock should require a tourbillon, but perhaps they were expected to be used at sea ? This is, of course, extremely improbable. These clocks were almost certainly made as examples of superb workmanship, and purely for the benefit of the connoisseur.

Speedometers

In 1904 the firm of Nicole Nielsen & Co. Ltd. began to manufacture speedometers at 14 Soho Square.

R. B. North appreciated that, with the application of the internal combustion engine to road vehicles, there would be a need for a reliable speedometer, not so much to see how fast the car would go, but rather to make sure that the driver did not find himself exceeding the new speed limit for these new " light locomotives " as they were called. He mentioned his idea to Samuel Smith (of S. Smith & Sons, watchmakers, 9 The Strand, London) and he was so impressed that he contracted to take all of the output of the speedometers made by R. B. North. This contract lasted until the latter part of 1909, when S. Smith decided to manufacture on their own. Accordingly R. B. North took out patent No. 4249 in 1909 to protect his interests. However, he failed to submit the necessary final specification and the patent was therefore " abandoned ".

Watford Speedometers

In order to meet the demand for these speedometers R. B. North opened a separate fatory in 1905 at Whippendale Road, Watford, in the name of " North & Sons ", for the manufacture of " Watford Speedometers ".

However, the original firm of Nicole Nielsen & Co. Ltd., 14 Soho Square, still retained its trade-name although owned by R. B. North.

From 1906 to 1911 Watford Speedometers made a small gross profit, and from 1912 to 1920, for part of which time they were

under Government control (during the war), they made an average profit of £5,000 a year. In 1914 the factory began to make magnetos for aeroplane engines.

As already mentioned, Charles Frodsham & Co. Ltd. opened a branch business in 1911 at 17 Dering Street for the sale of speedometers. It is almost certain that R. B. North supplied these speedometers, and, as pointed out, he eventually purchased the goodwill of this branch in 1916.

Sophus Emil Nielsen's Death

Emil Nielsen died at his home in Tooting on the 5th June, 1899. Administration of his Will was granted to his widow, Harriet Victoire Nielsen and his effects were valued at £31.3.2.

North & Sons Ltd., 14 Soho Square

In January, 1917, the name of the firm was changed from " Nicole Nielsen & Co. Ltd." to " North & Sons Ltd., 14 Soho Square ".

Following the war there was no longer a great demand for watches and so, in 1920, part of the premises were let to Alexander Anderson, a " boot closer ", and in 1933 this part was let to Naunton & McMurdo, solicitors. In 1934 they were no longer called " Watch Manufacturers ", instead they were called " Speedometer Manufacturers ". The factory closed down the same year.

During the 1920s the following workmen were employed by North & Sons Ltd. at 14 Soho Square : James Jansen (manager), and Messrs. M. Cooke, Roddy, Jimmy Naustead, H. Andrews and George and William Wenerstrom. All first-class watchmakers and finishers.

Watford Speedometers and Car Clocks

Here again, following the war there was no longer a great demand for magnetos and speedometers, and the Company found itself in need of capital with the idea of developing the manufacture of car clocks.

This idea was not a new one and already in **1914, Patent No. 17,264**, had been obtained in the name of **Nicole Nielsen & Co. Ltd.** This covered the use of a method of winding and setting a clock from the front.

The actual manufacture of these clocks commenced in about 1922. At the same time a similar movement, but having a rear winding mechanism, was built up as a small mantel clock; these were known as Watford clocks. They were sold by Frodshams, with the name " Frodsham " on the dial.

In 1921, in order to raise the necessary capital, R. B. North had agreed to sell the company seven parcels of land at Watford in exchange for £16,250 in shares, and the same day the Company mortgaged its freehold land at Watford, the factory building and the dwelling house, as security for an overdraft of £46,000.

Unfortunately their centrifugal type of speedometer was becoming obsolete in view of the development of a magnetic speedometer, and, in the same way, car magnetos were being replaced by the change over to a cheaper form of coil ignition, and so, from 1920 to 1932, there was a net loss of about £1,780 per annum.

Eventually, in 1932, a receiver and manager was appointed and the Company went into compulsary liquidation, which must indeed have been a sad blow for the 350 people employed by the firm at Watford, as well as for those employed at Soho Square. For further details of North & Sons Ltd. see *The Watch and Clock Maker* for December, 1933, page 303.

The factory at Watford was sold in 1933 to Messrs. Alfred Herbert Ltd. of Coventry for £46,200.

And so, North & Sons, speedometer, magneto and watch and clock manufacturees of Watford and Soho Square, came to a sad end. R. B. North senior had died in 1929, but, fortunately for the family, his wife was the major share holder of Charles Frodsham & Co. Ltd.

So much then for the firm which commenced as " Nicole & Capt ", let us now consider what happened to Henry Capt.

Henry Capt of Geneva

Henry Capt is first mentioned by name in the Post Office Directory for 1842, where his address is given as 56 Frith Street. In the Directory for 1841, however, the firm of Nicole & Capt, of 80B Dean street, is first mentioned, and in 1844 we find " Capt, Jules,

watchmaker. See Nicole & Capt ", and in 1876 we find the same information. What happened to Henry Capt ? Did he return to Geneva ? This seems to be the likely explanation.

When the Nicole & Capt partnership was dissolved in 1876 by the death of Jules Capt we find that Henry Capt opened a branch in his own name at 22 Sackville Street, and in 1879 he opened retail premises at 151 Regent Street; he described himself as " Henry Capt (of Geneva), Watch & Carriage Clock Manufacturer & Jeweller & the only watch manufacturer in Geneva having a retail branch in London ". No wonder so many well-made carriage clocks bear the name Henry Capt of Geneva, even if, as Charles Allix suspects, the clocks were of French origin.

In 1890 the premises at 151 Regent Street were taken over by T. Martin & Co., and we hear no more of Henry Capt.

CHAPTER XII

VARIETIES OF CHARLES FRODSHAM WATCHES

The firm of Charles Frodsham used either a ¾-plate or ½-plate for all their uncomplicated watches. Some varieties have already been mentioned, there are, however, others of interest :—

Floating or Hanging Barrel

This had been designed for Frodsham by Richard Bridgeman (who died in 1904). The barrel for this movement is as high as the upper surface of the top plate. It is secured to the bottom plate only, and has no upper support, hence its name. The object of the high barrel being to improve timekeeping by employing a high mainspring which could then be thinner, and therefore less likely to break. **Plate 80**, page 413. (In another model, without a hanging barrel, the top plate was raised over the high barrel.)

A series of these ½-plate watches was made between 1890 and 1892. They all have the 84 Strand address and were given a separate serial number, higher than for the ordinary watches being manufactured at that time. The numbers commence at 010012 and continue to 010209 for this special series, whilst the normal series number for 1891 is around 08231. Catalogues of this period describe these watches as " New calibre watches ".

Half-Chronometer

Some of Frodsham's watches were described as half-chronometers in the early catalogues. This was the name given to a watch of the highest quality, having a lever escapement and compensation balance and spring, which had been adjusted for temperature and timed in positions with all the attention bestowed upon a pocket chronometer. It was, in fact, nothing to do with a " chronometer ", which is accepted as having a detent escapement.

Time of Flight Instrument

In 1895 the firm began to make a "quick-acting micrometer chronograph". These watches had nickel cases and silvered dials. They showed seconds on an outer circle and 20ths of a second on a small circle, by means of a cylinder escapement, giving twenty vibrations per second.

By 1899 these had been improved so that the small circle read 100th part of a second. They were extremely accurate for short trials (up to 60 seconds), and were used for timing the flight of projectiles, etc. They cost £20 to make and were sold for £30. **Plate 92**, page 421.

Reversed Fusee

From 1850 onwards a number of watches were made with reversed fusees, and these were all marked AD Fmsz, as a sign of high quality. The best were free-sprung, and of excellent finish. Usually with lever escapements, but sometimes with detents.

Complicated Watches

These were of all the usual varieties, and, owing to lack of space. these usually had going barrels.

Frodshams were renowned for their pocket chronometers and complicated watches so that it is not surprising to find that the Ilbert Collection at the British Museum contains examples of the most interesting types such as :—

Independent centre seconds.
Nos. 01316 and 03230. **Plates 72 and 74**, page 411.

Minute repeaters.
Nos. 02418 and No number. **Plates 81 and 83**, page 414.

Spring detents.
Nos. 8645, 01380 and 03503. **Plates 71, 75 and 76**, pages 411 - 412.

Full plate lever.
No. 01191. **Plate 73**, page 411.

8-day lever.
No. 06398. **Plate 77**, page 412.

Perpetual calendar.
No number. **Plate 83**, page 414.

Fixed winder.
No. 01380. **Plate 75**, page 412.

Two more examples come from private collections :—

Chronograph.
No. 07820. **Plate 84**, page 415.
Minute repeating clock watch.
No. 08157. **Plate 88**, page 417.

Unusual Watches

A number of watches appear to have been experimental, and exhibit unique features.

No. F/7014, Arnold, Chas. Frodsham, has an unusual tuning fork type of banking. Club tooth lever. Reversed fusee. AD Fmsz.

No. F/7015, Arnold, Chas. Frodsham, has a normal fusee with a free-sprung detent escapement. Flat balance spring with a 3-coil overcoil. The stud on the cock which takes the overcoil is held in place by one of the cock jewel-hole screws.

No. 02669, AD Fmsz, fecit 1865, has Cole's Resilient escapement, i.e., the notched teeth on the escape wheel act as the resilient banking. Free-sprung. Reversed fusee.

No. 03520, which has its pillar plate engraved " 1867 ", has a pair of balance springs close to one another, one expands as the other contracts. It is free-sprung and has a reversed fusee. Another unusual feature is that it has spring banking, and has a long spring carrying a vertical pin. This spring is at right-angles to a forked tail on the pallets arm. **Plate 86**, page 416.

No. 03530, AD Fmsz, fecit 1867, has Cole's spring-tail resilient banking as used by Dent. Free-sprung. Reversed fusee.

No. 05872, 84 Strand. Chronograph. Unusual double roller. The rollers are inverted, the larger roller being below the smaller, the former having a smaller than usual outside diameter and incorporating a rectangular jewel pin which projects beyond the diameter of the roller itself. The sides of the lever notch are not parallel but converge inwards slightly.

No. 06018, has a method of spring banking similar to that employed in No. 03520. The movement is made of nickel. Going barrel. Free sprung. The balance spring is a modification of the double overcoil and duo-in-uno types. H.M. 1882.

No. 07629, has a spring-tail lever escapement similar to the Dent type.

Tourbillons and Karrusels

A number of these were made, and they were always of high quality, and these were often awarded Kew Certificates. The highest marks were won in 1906 when No. 09182 was awarded 93.9 marks out of 100.

No. 09572

Of all the tourbillons made for the firm, No. 09572 is probably the finest. It was ordered before the war and was not completed until over a year later. It is in a gold case, H.M. 1915. AD Fmsz., and has a perpetual calendar with phases of the moon. In addition to this it is a minute repeater, and a clock-watch. It is a minute revolving tourbillon with lever escapement of English design, and was probably made by the firm of Nicole Nielsen, under the auspices of R. B. North.

The owner's only complaint was that it had to be wound up every day! **Plates 90 - 91**, pages 419 - 420.

There is an amusing story concerning this watch. As already explained, this watch was ordered before the war and for six years nothing was heard of the gentleman who ordered it and so it was eventually sold to someone else. No sooner had Frodshams sold the watch than, a week or two later, they received a cheque from the man who had originally ordered it with a letter asking for his watch. The firm wrote and explained what had happened, and the customer replied " Make me another ", which in due course they did.

A year or two later a traveller in a train going to Cornwall pulled out his watch to look at the time. Turning to the only other occupant of the carriage he said, " Ever seen a watch like this ? ". The second gentleman put his hand into his waistcoat pocket and pulled out his own watch. They were identical.

The story is perhaps confirmed by the fact that there is in existence another Frodsham tourbillon with perpetual calendar, minute repeating and clock-watch mechanisms; it is No. 09642, and bears the address 27 South Molton Street. The hall-mark is not known, but from its number it would appear to have been made in about 1917, which would fit in fairly well with the story.

In tourbillons and karrusels the escapement and the balance are placed on a revolving platform (hence the names) with the idea of abolishing the errors due to the effects of a change of position of a watch when in any of the vertical positions. One way to cure this is to make the entire mechanism revolve, as seen in the Waterbury watch, but, since the errors are almost entirely due to the change of position of the balance and its escapement, it is only necessary to make this part of the watch mechanism revolve. Since the change of position of the balance is the most important factor, it follows that the nearer the balance is to the centre of the revolving platform the better.

What is the difference between a tourbillon and a karrusel ? The definition given to me by Anthony Randall seems to be a good simple one :—

In tourbillons the escapement is driven by the revolving platform or " carriage ".

In karrusels the escapement is driven directly by the train. It follows, therefore, that in this case the carriage must have a hollow central arbor to allow for the passage of a train arbor to drive the escapement.

There are two ways of driving the carriage of a tourbillon. One is to drive the carriage by a pinion fixed to the centre of the underside of the carriage, the other is by having teeth at the circumference of the base of the carriage which are driven by one of the train pinions. The karrusel carriage can also be driven in these two ways, but in the first method the central pinion must be hollow to allow for the passage of a train arbor.

All tourbillons must have a fixed wheel on the pillar plate to enable the carriage to drive the escapement. In karrusels there is no such fixed wheel on the pillar plate.

If a tourbillon is mounted on the fourth pinion (the seconds hand arbor) the carriage will revolve in 1 minute. If it is mounted on the third pinion it will revolve in either 4 or 6 minutes. If the carriage is driven by the fourth pinion it can revolve in 4 or 5 minutes, and if driven by the centre wheel it usually revolves in 60 minutes.

In a karrusel, on the other hand, the rate of rotation of the carriage bears no direct relation to the rate of rotation of the train wheels, so that the carriage may revolve, for example, in 29, 34, 39 or $52\frac{1}{2}$ minutes.

Therefore by timing exactly the rate of rotation of the carriage we have a fairly reliable method of distinguishing a karrusel from a tourbillon.

Charles Frodsham & Co. Ltd. used both types in some of their high-class watches. A karrusel whose movement was made by Bonniksen and finished by Nicole Nielsen in 1896 has the number 08500. In the same year Nicole Nielsen supplied Frodshams with a centre seconds tourbillon No. 08501 in a silver case for £14.2.6.

One point of interest, Frodshams never used a detent escapement in any of their tourbillons, they always employed a lever escapement often with a double roller, even in their " best tourbillons ". Other makers, such as Dent, sometimes used a spring detent, but only in their very best watches.

There are, of course, a number of varieties of tourbillons and karrusels, quite apart from those designed by Breguet, and six of these are covered by British patents, several of which are to be found in Frodsham watches. For the sake of completeness I propose to describe all six patents in simple terms, commencing with the types invented, in the first place, by Breguet.

Tourbillons

1. **Breguet type** (60 second). Invented 1795. Patented 1801.

Carriage mounted on the 4th pinion.

The 4th wheel is a fixture, being screwed to the pillar plate. The 3rd wheel drives the 4th pinion, and the 4th pinion being fixed to the carriage, forces the carriage to revolve. Since the carriage revolves once a minute, the 4th pinion arbor carries the

seconds hand. The escape wheel is driven by its pinion which engages with, and revolves round, the fixed 4th wheel. The escape wheel therefore turns in a reverse direction to the normal. The escapement is driven by the carriage. **Plate 93**, page 422.

2. **Breguet types** (4 minute and 6 minute).
Carriage mounted on the 3rd pinion.

The 3rd wheel is a fixture, being screwed to the pillar plate. The 4th wheel is mounted on the carriage, its pinion being driven by the fixed 3rd wheel. The escapement is therefore driven by the carriage. **Plate 93**, page 422.

3. **Taylor, Andrew.** Patent No. 16,623. A.D. 1895 (60 minutes).
The carriage is driven by the centre wheel or by a supplementary wheel. The 3rd wheel, 4th wheel and the escapement are all mounted on the carriage. The 3rd pinion receives power, via an idle wheel, from an internally cut wheel (an annular wheel) which is fixed to the pillar plate.

In the Breguet types the carriage was driven by a centrally placed pinion, whereas in the Taylor the carriage has a number of teeth around its rim which receive power from the centre wheel.

In all the above, the carriage is pivoted a b o v e and below. **Plates 94 - 95**, pages 423 - 424.

4. **North, Robert Benson.** Patent No. 6737. A.D. 1903 (4 minute and 5 minute).

The carriage is mounted upon a steel stud, which is fixed in the pillar plate. The 4th wheel is a fixture which is screwed to the pillar plate. The carriage is mounted centrally over the fixed 4th wheel.

Through a hole in the carriage a pivoted pinion is driven by the fixed 4th wheel as the carriage revolves. This pinion drives the escapement. The carriage platform has a number of teeth on its rim. These teeth are driven by a small steel wheel on the 4th pinion. If the carriage has 100 teeth and the steel wheel 20 teeth, the carriage will revolve in 5 minutes, but if the carriage has 108

teeth and the steel wheel 18 teeth, then the carriage will revolve in 6 minutes. **Plates 95 - 96**, pages 424 - 425.

In this type the carriage is only pivoted at the bottom. It is therefore called " a Flying Tourbillon ". There is, however, no reason why the North carriage should not be pivoted above as well as below.

5. **Burtin, Joseph**, of Doubs, France. Patent No. 7888. A.D. 1905 (60 seconds).

Although this is in fact a tourbillon it is sometimes called "A False Tourbillon ", because, although the carriage drives the escapement, the lay-out is such that the balance is very much off-centre as regards the carriage. This is considered to be a disadvantage, although it is much easier to manufacture. Although this has a British patent I doubt if it was ever employed in an English watch.

The carriage is pivoted at both ends. The fourth wheel is fixed to the plate, and, as the carriage revolves, the escape wheel pinion is driven by the fixed 4th wheel. The carriage is driven by the 4th pinion. **Plates 97 - 98**, pages 426 - 427.

Karrusels

1. **Bonniksen, Bahne.** Patent No. 21,421. A.D. 1892 ($52\frac{1}{2}$ minutes).

The carriage is not pivoted at the upper end, but has a large brass hollow pivot or boss which rotates in a large brass hole in the pillar plate. This boss has a special flat wheel with 70 teeth secured to the dial side of the boss with three screws. This special wheel is driven by the 3rd pinion which usually has 10 leaves. Therefore the 3rd pinion revolves seven times for one revolution of the carriage. One revolution of the 3rd pinion usually takes $7\frac{1}{2}$ minutes, therefore 7 revolutions takes $52\frac{1}{2}$ minutes.

This special wheel has a central circular aperture to allow for the passage of 4th pinion. The arbor of this pinion lies in the centre of the carriage, so that the 4th wheel can drive the escape wheel pinion. The escapement is therefore driven directly by the train. **Plates 98 - 99**, pages 427 - 428.

2. **Bonniksen.** Centre seconds Karrusel (34 minutes).

In a centre seconds watch the 4th pivot, which revolves once a minute, has to be in the centre of the frame of the watch. The carriage differs from the first type :—

> There is no special flat wheel on the dial side of the boss, but instead there is a plain brass disc which is secured to the boss. The rim of the carriage has an extra rim, provided with 136 teeth, screwed on to the outside edge. This rim is geared into a steel wheel having 30 teeth. This steel wheel is mounted on the 3rd pinion arbor, instead of being turned by the 3rd pinion.

The 4th wheel is driven in the usual way and is geared into a wheel of the same number, having another wheel mounted on its arbor, which drives the escape wheel pinion on the carriage. The carriage is not pivoted at the top. **Plates 100 - 101**, pages 429 - 430.

3. **Bonniksen.** " The Bonniksen Tourbillon " (39 minutes). 1903.

This is not a true tourbillon, it is in fact a karrusel. The carriage is pivoted above and below. Around the rim of the carriage there are a number of teeth. These teeth are driven by an intermediate wheel, which is itself driven by the third wheel. The intermediate wheel is introduced in order to make the carriage revolve the reverse way to the fourth wheel. The bottom pivot of the carriage is hollow in order to admit the fourth pinion freely, and this, of course, drives the escape wheel. **Plates 100 - 101**, pages 429 - 430.

4. **Holland, William and Ernest Arthur.** Patent No. 20,235. A.D. 1902 (29 minutes).

The carriage is pivoted above and below, i.e., it has upper and lower bearings. The upper bearing is actually on top of the cock. The lower bearing is hollow to allow the fourth pinion to pass through it and so drive the escapement. There are two ways of driving the carriage; in the first way the carriage has a hollow

pinion at its base, and in the second way the carriage has a number of teeth around its rim, as well as a hollow pinion at its base. The centre wheel drives this hollow pinion thereby rotating the carriage. The teeth on the rim of the carriage now take the place of a train wheel and drive the third pinion and the third wheel drives the central fourth pinion. So that, in effect, " the carriage is driving the escapement ", in other words it could be called a " tourbillon ". However this can be regarded as the exception which proves the rule, because, as in all karrusels, the carriage has a hollow central pinion to allow for the passage of the fourth pinion arbor. It can therefore be regarded as a genuine karrusel. **Plates 102**, **104**, pages 431, 433.

5. **Douglas, William Henry.** Patent No. 6858. A.D. 1906 (39 minutes).

This is a karrusel movement which is designed in such a way that a chronograph mechanism can be added if required, and be driven by the fourth pinion carrying the seconds hand.

The carriage has a fixed wheel screwed to its base. The centre wheel drives this fixed wheel.

The carriage is maintained in position by a hollow countersunk screw at the centre of the base of the carriage. As described in the patent it has no upper bearing, but as seen in a watch made by Douglas, No. 1910, an upper bearing can be applied by means of a bar type cock.

The train has two fourth pinions, one below the centre of the carriage with its arbor passing through the hollow screw to drive the escapement, the other is placed to one side and carries the subsidiary seconds hand. These two fourth pinions are connected by an idle wheel. **Plates 103 - 104**, pages 432 - 433.

Charles Frodsham & Co. Ltd.

List of Tourbillons and Karrusels

4/1891	Karrusel.	Lever.	1896 Bonniksen.
08300	Karrusel.	,,	1901 Furneaux.

08501	Tourbillon.	Lever.	1896	N. & N.	Centre Seconds
08616	,,	,,	1898	N.N. & Co.	Min. Rep. Chronograph
08617	,,	,,	,,	,,	Min. Rep. Chronograph
08647	,,	,,	1899	,,	Fusee
08753	1 min. ,,	,,	1900	,,	Fusee
08767	Karrusel.	,,	1899	Golay	Chronograph
08768	,,	,,	1899	,,	Chronograph
08814	Tourbillon.	,,	1900	N.N. & Co.	Min. Rep. Chronograph
08827	,,	,,	1900	,,	Min. Rep. Chronograph
08845	,,	,,	1901	,,	Min. Rep. Chronograph
08868	,,	,,	1902	,,	Fusee
08895	Karrusel.	,,	1902	,,	
08897	Tourbillon.	,,	1902	Furneaux	Min. Rep. Chronograph
08920	1 min. ,,	,,	1903	,,	Min. Rep. Chronograph
08921	,, ,,	,,	1903	,,	Min. Rep. Chronograph
08922	Tourbillon.	,,	1903	N.N. & Co.	Min. Rep. Chronograph
08928	,,	,,	1902	,,	
08948	Karrusel.	,,	1903	Bonniksen	
08949	,,	,,	1903	,,	
08959	,,	,,	1902	Milne	Centre Seconds
08964	Tourbillon.	,,	1903	N.N. & Co.	
08978	,,	,,	1903	,,	
08982	Karrusel.	,,	1904	Furneaux	
08991	Tourbillon.	,,	1905	N.N. & Co.	Fusee
08992	,,	,,	1910	,,	Fusee, Best
09050	Karrusel.	,,	1903	Bonniksen	
09060	Tourbillon.	,,	1905	N.N. & Co.	

09072	Tourbillon.	Lever.	1904	N.N. & Co.	Best
09082	,,	,,	1906	Carley & Clemence	Annular Tourbillon per Taylor
09097	Karrusel.	,,	1905	Bonniksen	
09099	Tourbillon.	,,	1906	N.N. & Co.	
09128	,,	,,	1905	,,	Fusee
09133	,,	,,	1906	,,	Fusee, Best
09152	,,	,,	1907	,,	Min. Rep. Chronograph
09171	,,	,,	1907	,,	Fusee
09182	,,	,,	1907	,,	Fusee
09190	6 min. ,,	,,	1907	,,	
09256	Tourbillon.	,,	1909	,,	Best Chronograph
09269	,,	,,	1909	,,	Best Fusee
09312	,,	,,	1910	,,	Best Min. Rep. Chronograph
09319	Traveller.	,,	1901	,,	
09364	Tourbillon.	,,	1919	North & Son	
09365	,,	,,	1910	N.N. & Co.	Fusee
09416	,,	,,	1911	,,	
09428	,,	,,	1912	,,	¼ Rep.
09513	,,	,,	1913	,,	
09562	,,	,,	1914	,,	Fusee
09572	,,	,,	1915	,,	Perpetual Calendar, Minute Repeater, Clock-Watch
09573	,,	,,	1916	,,	Fusee
09642	,,	,,		,,	Perpetual Calendar, Minute Repeater, Clock Watch
09655	,,	,,	1916	,,	Fusee

09672	Karrusel.	Lever.	1916	N.N. & Co.	
09692	Tourbillon.	,,	1917	North & Son	Fusee
09714	,,	,,		,,	Clock Watch
09780	,,	,,	1918	,,	Fusee
09820	,,	,,	1922	,,	Fusee
09831	,,	,,	1924	,,	Fusee
09850	,,	,,	1923	,,	Fusee
09936	1 min. ,,	,,	1925	,,	Fusee
09947	Traveller.	,,	1925	,,	
09948	Revolving.	,,	1925	,,	Fusee
09973	Tourbillon.	,,	1926	,,	Fusee
010295	,,	,,	1928		

(The author is uncertain as to the meaning of the term " Traveller ".)

CONCLUSION

In coming to the end of this fact-finding mission I should like to remind the reader that this is really the story of a family of " chronometer makers " who also made watches and clocks. The chronometer side of the business led William James Frodsham, his son, Charles Frodsham, and his grandsons, Charles Mill Frodsham and Harrison Mill Frodsham, to contrive ways of improving these machines especially with regard to the construction of the compensation balance.

Nevertheless one has to admit that the firm which has left us some of the finest examples of watches and chronometers is that of Charles Frodsham, perhaps largely due to its association with Nicole Nielsen and Co. Lucky indeed are the owners of examples of their complicated watches and tourbillons. Let us not forget that the vast majority of these watches were made in Great Britain, although sometimes the repeating work was made in Switzerland.

Finally, I should like to say that the other famous watchmaking firm which is still in existence is that of Dent and Co. Ltd., whose creations can be considered to have been on a par with those of Charles Frodsham and Co. Ltd., whilst the firm of Thomas Mercer continues to maintain the tradition of fine chronometer making.

APPENDICES

When John Roger Arnold and Edward John Dent died they were both childless, and there were no true descendents to continue their lines, but in the case of the Frodshams we find quite a different situation, they nearly all had children. The resulting family trees, though by no means complete, are given in the following appendices.

In all these family trees the names of clockmakers are printed in heavy type.

Appendix I. The family tree of the Frodshams of Elton. This is a simplified version to show how the Elton Frodshams came to have no Frodsham heir with the death of Peter Frodsham of Elton in 1766.

It is possible that the London Frodshams were descended from a member of this branch of the family, but so far no link has been established with William Frodsham (the Elder) whose family tree is to be found on page .

Appendix II. The family tree of Alice Frodsham. She was a daughter of William Frodsham (the younger).

Appendix III. The lengthy family tree of William James Frodsham, one of Alice's brothers. One of his great-grand-daughters was Minnie Gertrude Frodsham who died in 1954. In her Will, made in 1950, she gave legacies to five cousins, Mrs. Connie Vulliamy, Miss Constance Vulliamy (both of Missouri, U.S.A.), Mrs. Winifred Westley (of Melbourne, Australia), "Louise Frodsham" (Mrs. Lister) of London, and Miss Emmie Frodsham of Crowthorne, Bucks. Minnie Gertrude Frodsham's mother was Mary Maria Frodsham, and the relationship between the Frodshams and the Vulliamys is explained in Appendix VI. Emmie Frodsham was the daughter of George Horsfall Frodsham, see Appendix IV, but not, probably, a true cousin of Minnie Gertrude Frodsham. Mrs. Lister has not been traced as yet.

Appendix IV. The family tree of George Horsfall Frodsham.

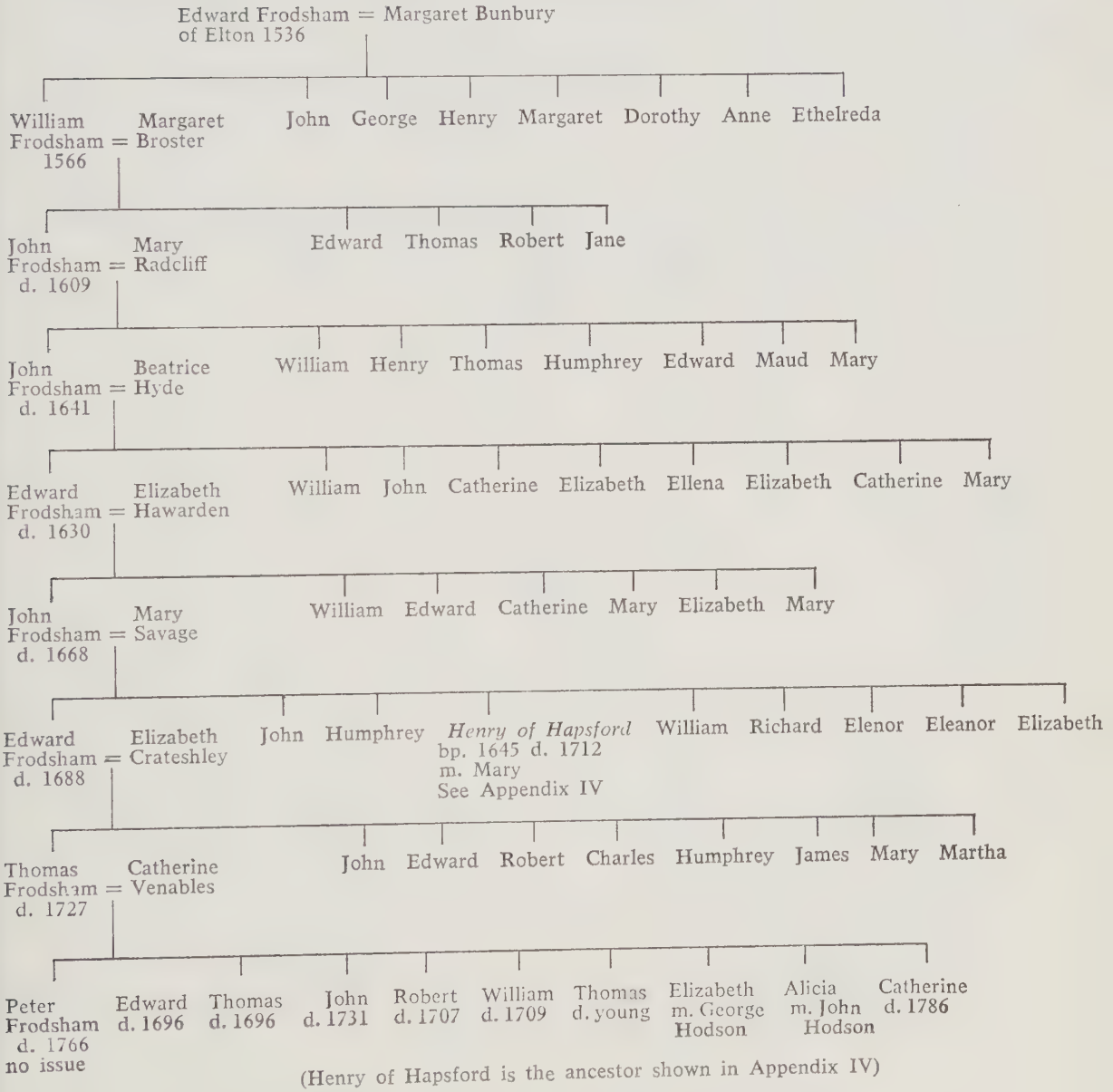
Appendix V. The family tree of an American branch of the Frodsham family. This has been included to show the relationship of the Hyrum Plumer Frodsham (marked with *) who succeeded in claiming the fortune deposited in Chancery, as mentioned on page 146. The Edward Frodsham, who married Sarah Winstanley, was a watchmaker, and lived at Duke Street, St. Helens, Lancashire. His son, James Frodsham, also a watchmaker, is believed to have emigrated to America in 1840.

So far, no connecting link has been found between the London Frodshams and this Edward Frodsham.

Appendix VI. The family tree of Maria Frodsham, showing how she was related to the Vulliamy family.

APPENDIX I

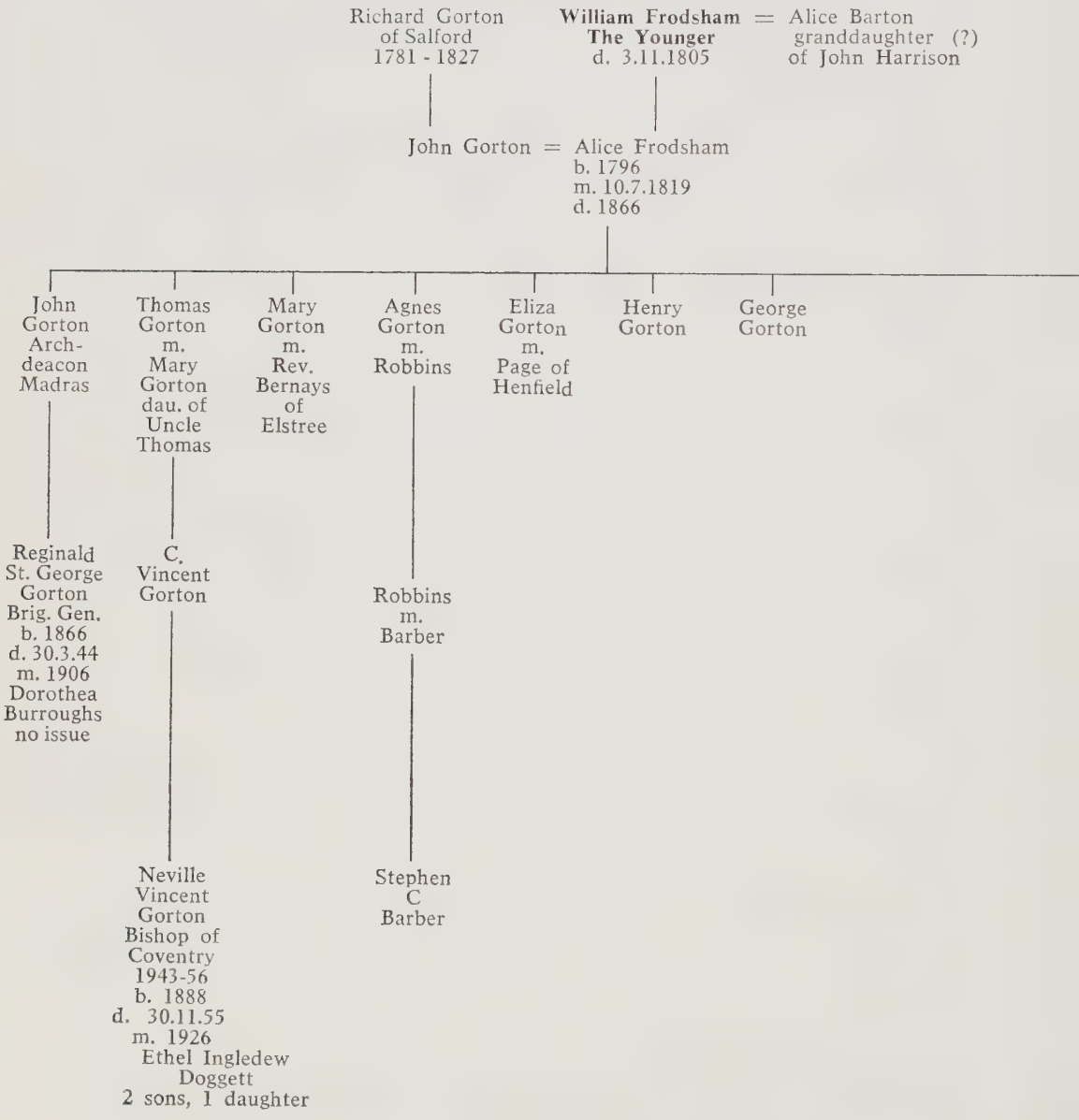
THE FRODSHAMS of ELTON


Edward Frodsham = Margaret Bunbury
of Elton 1536
William Frodsham = Margaret Broster 1566
John George Henry Margaret Dorothy Anne Ethelreda
John Frodsham = Mary Radcliff d. 1609
Edward Thomas Robert Jane
John Frodsham = Beatrice Hyde d. 1641
William Henry Thomas Humphrey Edward Maud Mary
Edward Frodsham = Elizabeth Hawarden d. 1630
William John Catherine Elizabeth Ellena Elizabeth Catherine Mary
John Frodsham = Mary Savage d. 1668
William Edward Catherine Mary Elizabeth Mary
Edward Frodsham = Elizabeth Crateshley d. 1688
John Humphrey Henry of Hapsford bp. 1645 d. 1712 m. Mary See Appendix IV William Richard Elenor Eleanor Elizabeth
Thomas Frodsham = Catherine Venables d. 1727
John Edward Robert Charles Humphrey James Mary Martha
Peter Frodsham d. 1766 no issue
Edward d. 1696
Thomas d. 1696
John d. 1731
Robert d. 1707
William d. 1709
Thomas d. young
Elizabeth m. George Hodson
Alicia m. John Hodson
Catherine d. 1786

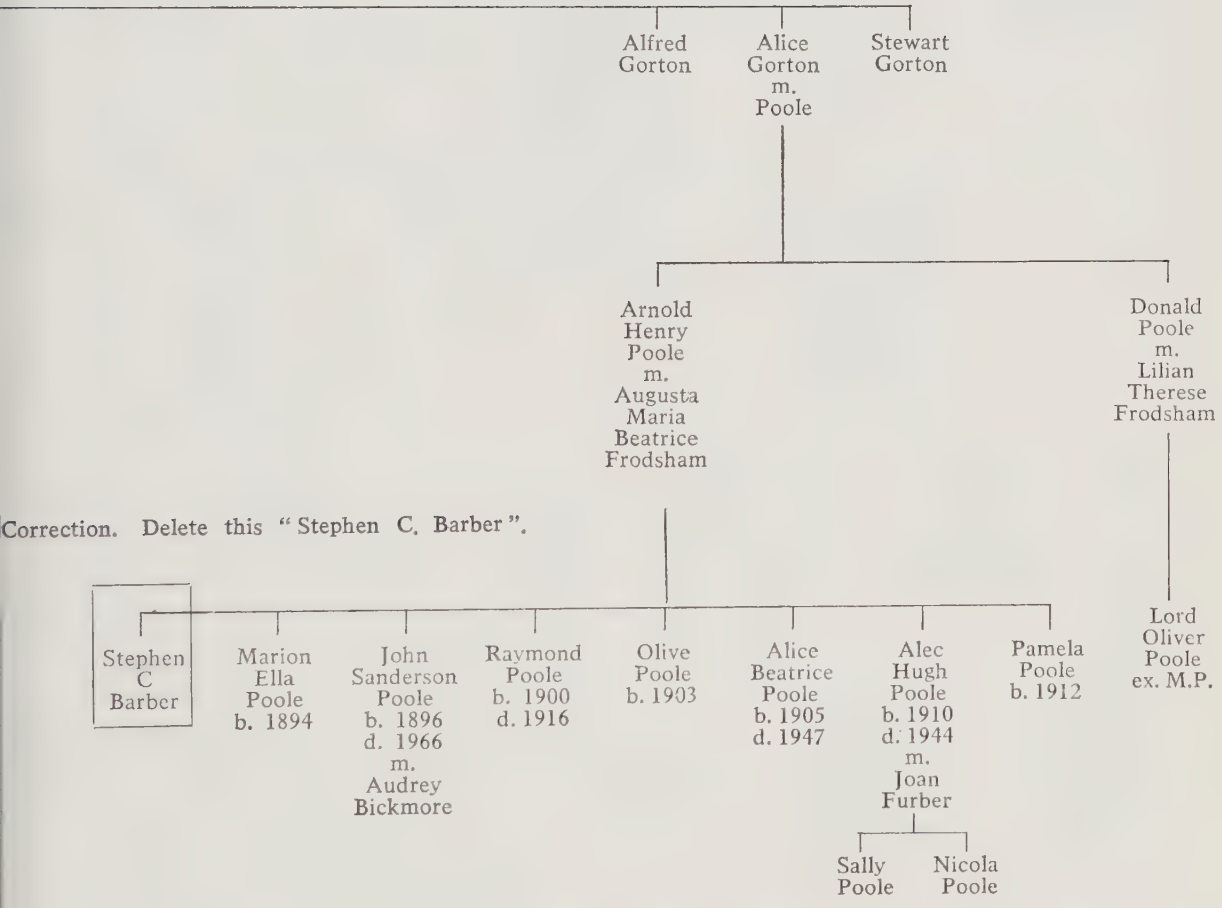
(Henry of Hapsford is the ancestor shown in Appendix IV)

APPENDIX II

ALICE FRODSHAM'S FAMILY TREE

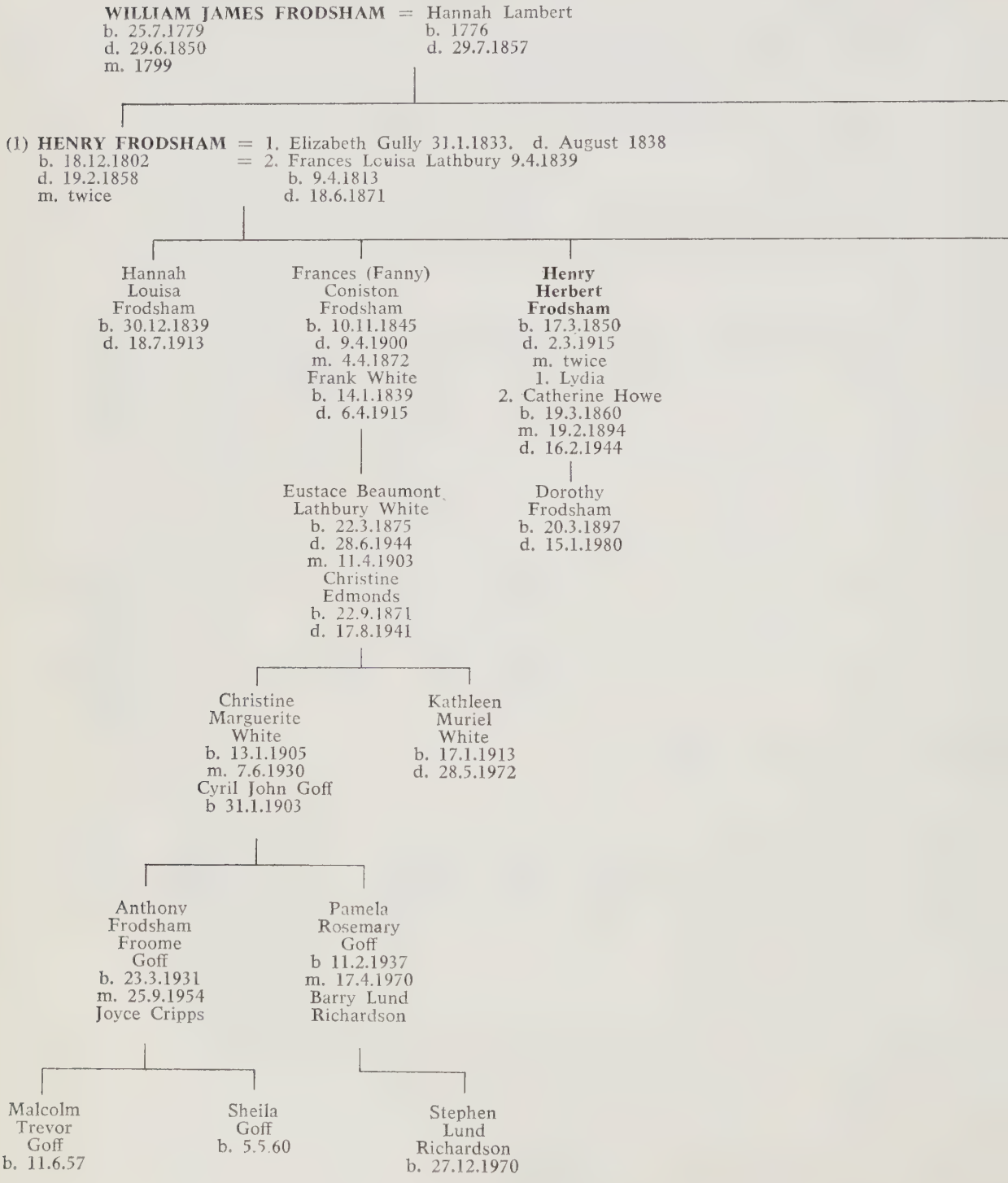

Richard Gorton of Salford 1781 - 1827
William Frodsham The Younger d. 3.11.1805
Alice Barton granddaughter (?) of John Harrison
John Gorton
Alice Frodsham b. 1796 m. 10.7.1819 d. 1866
John Gorton Arch-deacon Madras
Thomas Gorton m. Mary Gorton dau. of Uncle Thomas
Mary Gorton m. Rev. Bernays of Elstree
Agnes Gorton m. Robbins
Eliza Gorton m. Page of Henfield
Henry Gorton
George Gorton
Reginald St. George Gorton Brig. Gen. b. 1866 d. 30.3.44 m. 1906 Dorothea Burroughs no issue
C. Vincent Gorton
Robbins m. Barber
Neville Vincent Gorton Bishop of Coventry 1943-56 b. 1888 d. 30.11.55 m. 1926 Ethel Ingledew Doggett 2 sons, 1 daughter
Stephen C Barber

ALICE FRODSHAM'S FAMILY TREE

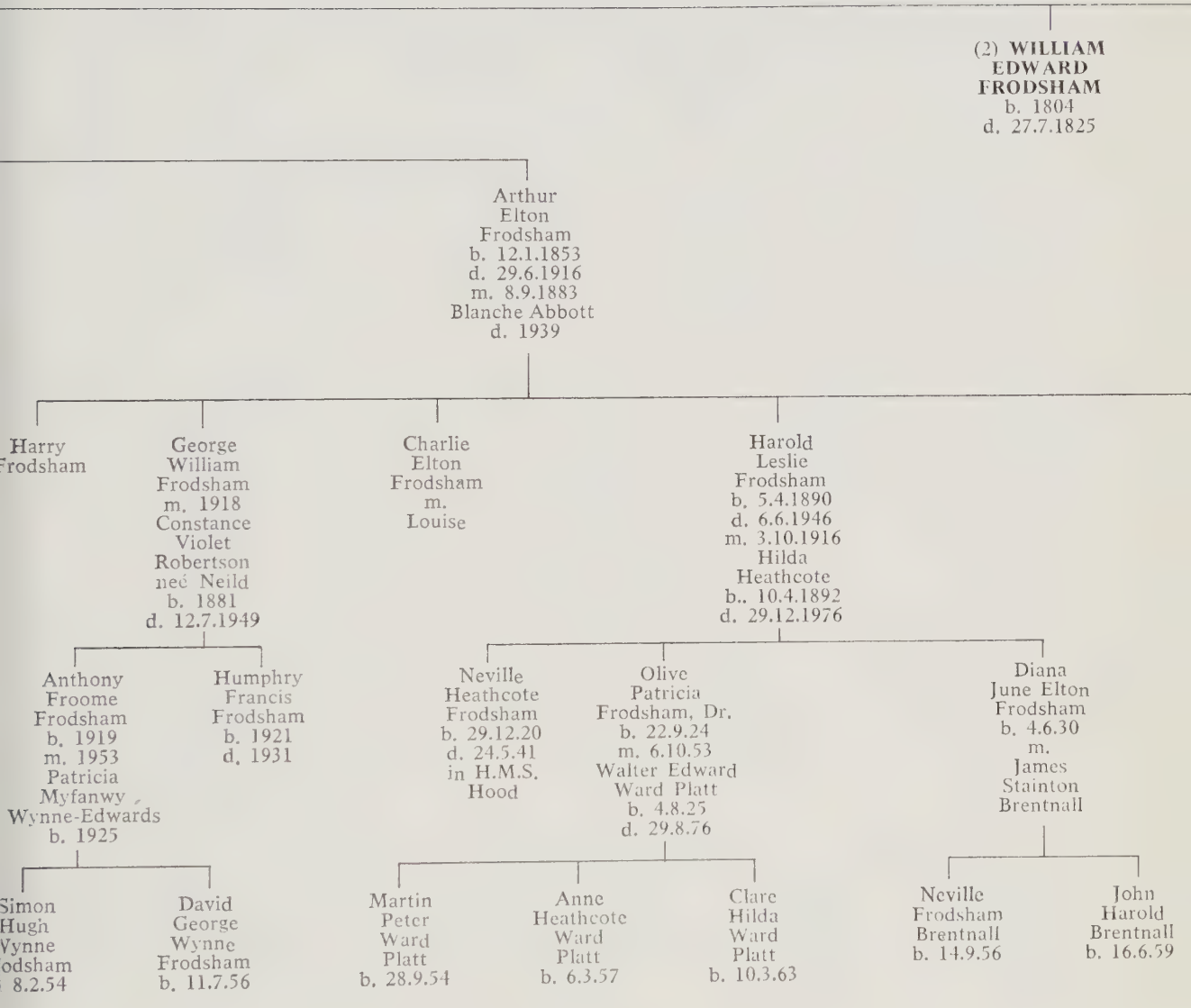

Alfred Gorton
Alice Gorton m. Poole
Stewart Gorton
Arnold Henry Poole m. Augusta Maria Beatrice Frodsham
Donald Poole m. Lilian Therese Frodsham
Correction. Delete this "Stephen C. Barber".
Stephen C Barber
Marion Ella Poole b. 1894
John Sanderson Poole b. 1896 d. 1966 m. Audrey Bickmore
Raymond Poole b. 1900 d. 1916
Olive Poole b. 1903
Alice Beatrice Poole b. 1905 d. 1947
Alec Hugh Poole b. 1910 d. 1944 m. Joan Furber
Pamela Poole b. 1912
Sally Poole
Nicola Poole
Lord Oliver Poole ex. M.P.

APPENDIX III

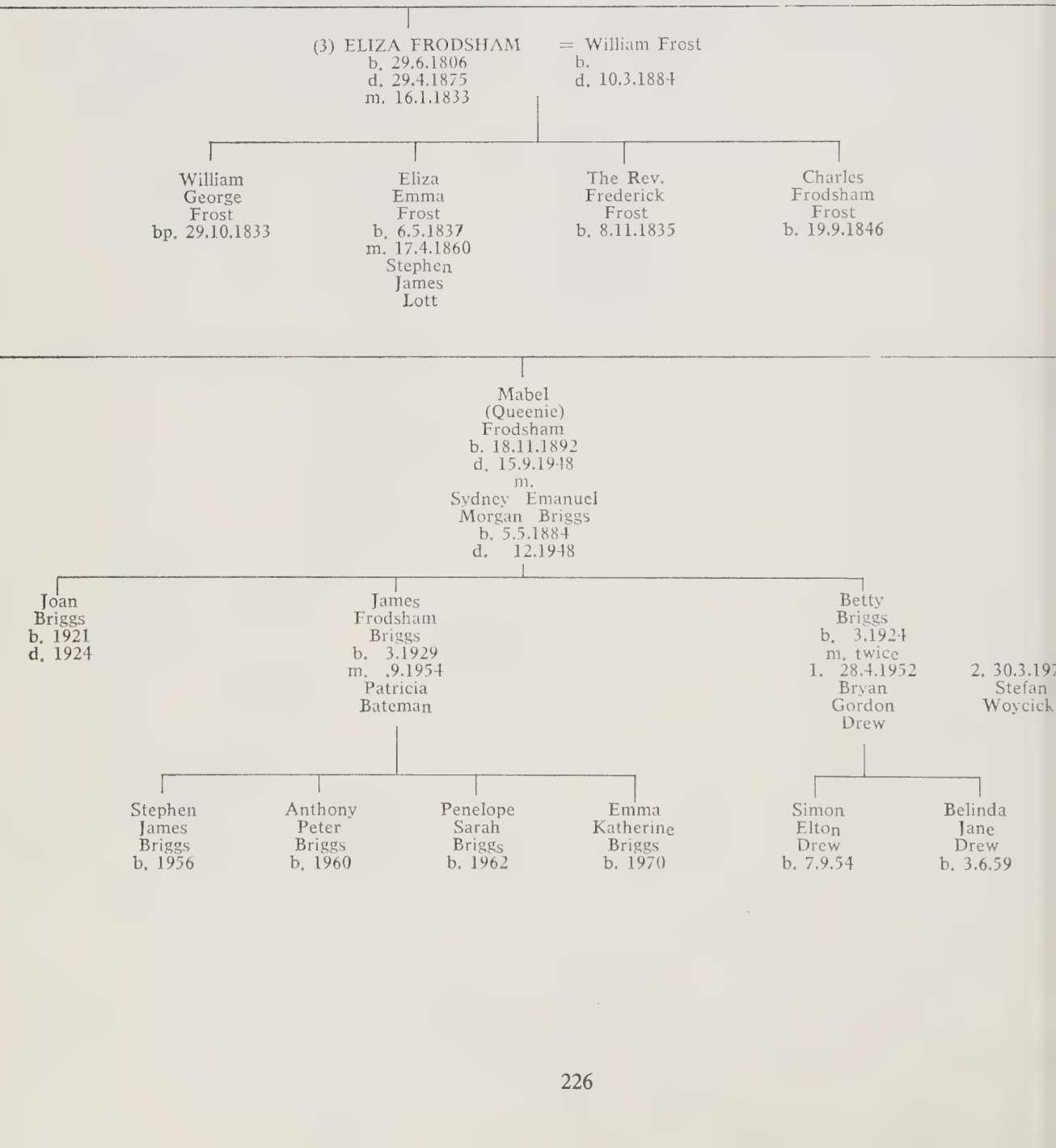
THE WILLIAM JAMES FRODSHAM FAMILY TREE



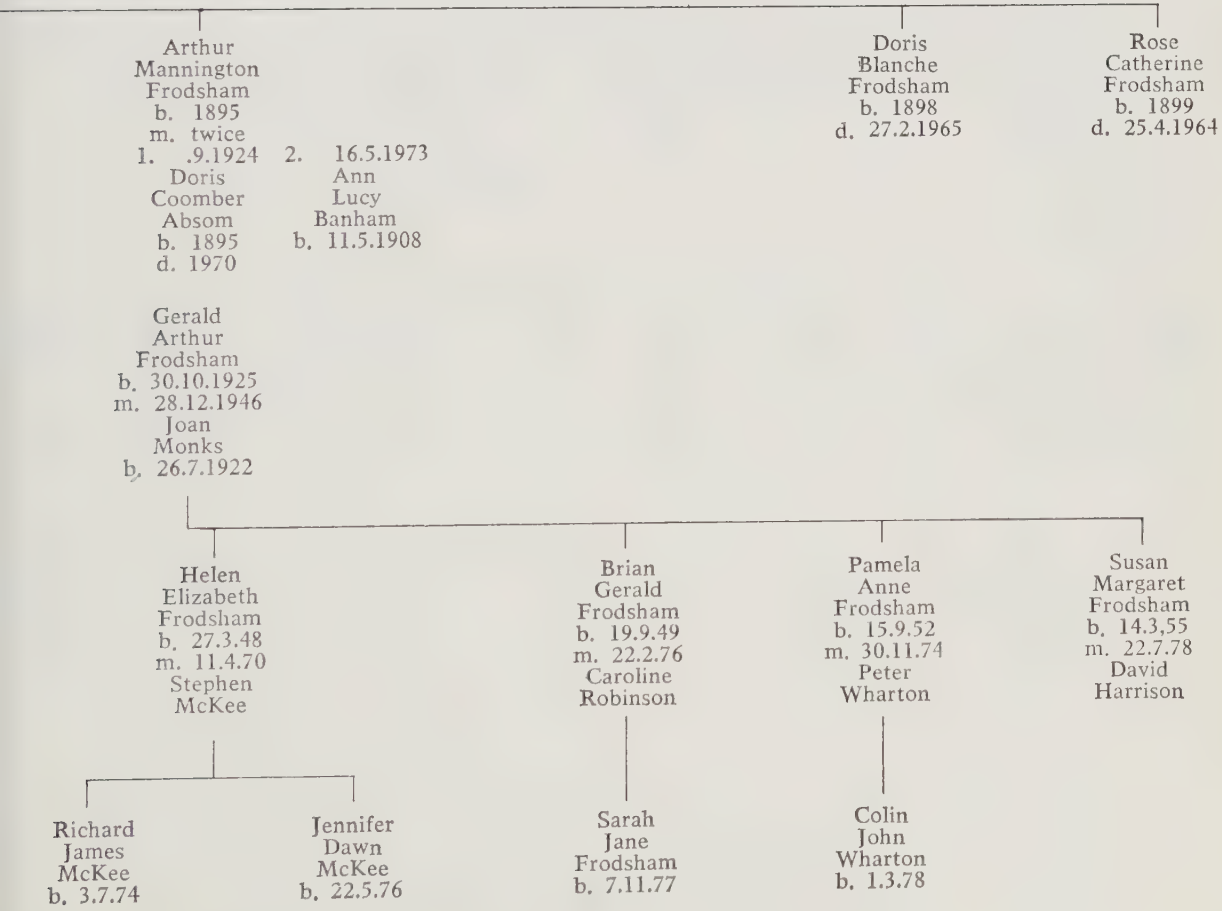
WILLIAM JAMES FRODSHAM FAMILY TREE



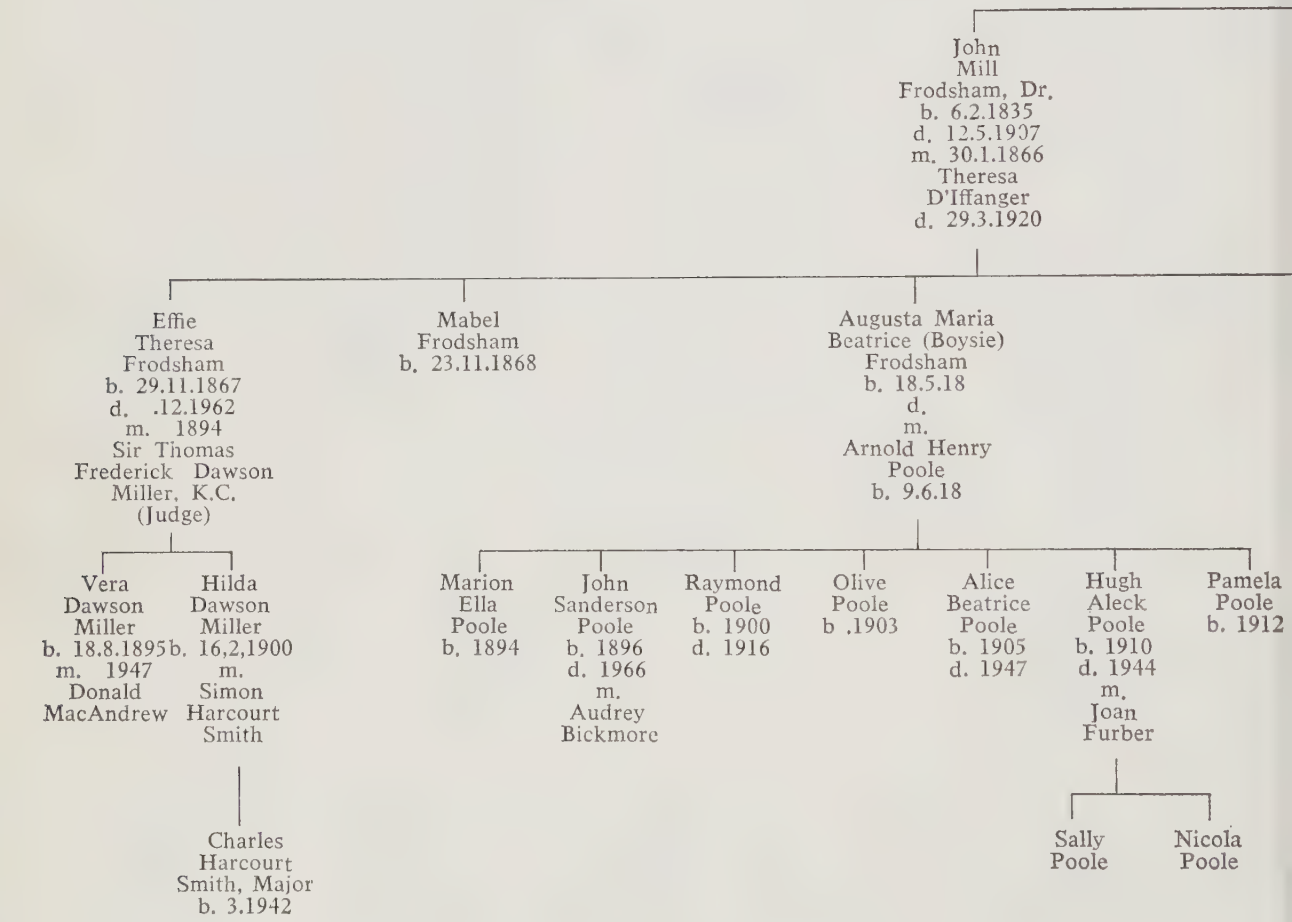
WILLIAM JAMES FRODSHAM FAMILY TREE



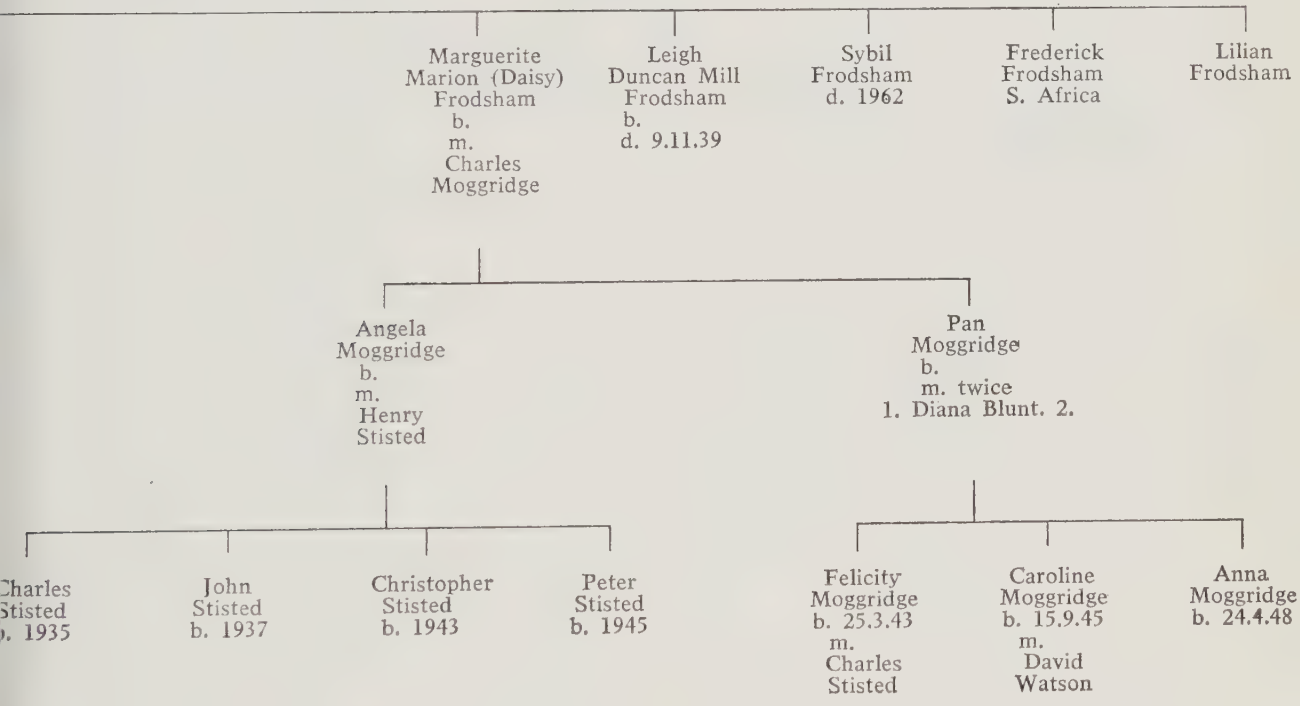
WILLIAM JAMES FRODSHAM FAMILY TREE

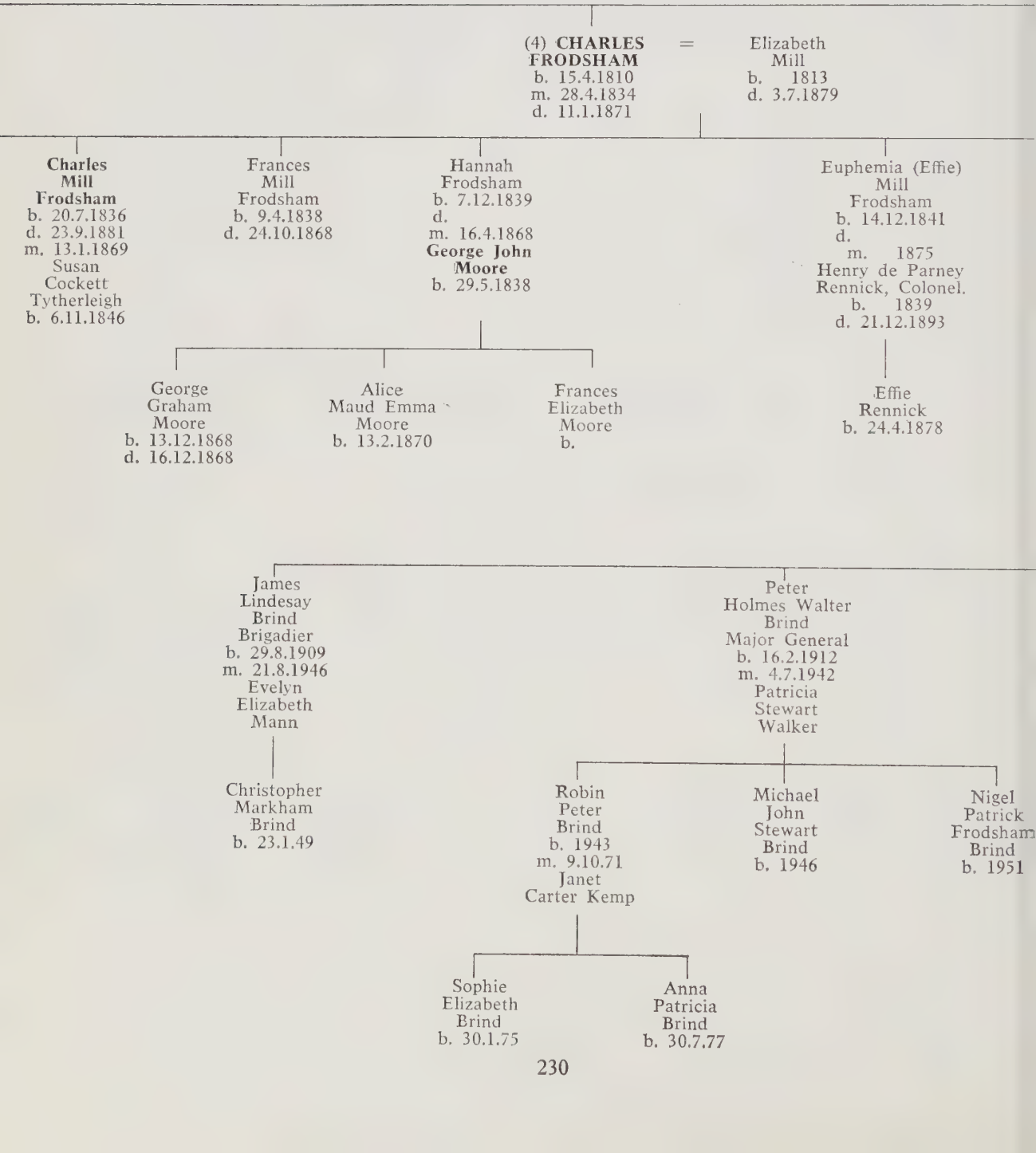

Arthur Mannington Frodsham b. 1895 m. twice 1. .9.1924 Doris Coomber Absom b. 1895 d. 1970
2. 16.5.1973 Ann Lucy Banham b. 11.5.1908
Doris Blanche Frodsham b. 1898 d. 27.2.1965
Rose Catherine Frodsham b. 1899 d. 25.4.1964
Gerald Arthur Frodsham b. 30.10.1925 m. 28.12.1946 Joan Monks b. 26.7.1922
Helen Elizabeth Frodsham b. 27.3.48 m. 11.4.70 Stephen McKee
Brian Gerald Frodsham b. 19.9.49 m. 22.2.76 Caroline Robinson
Pamela Anne Frodsham b. 15.9.52 m. 30.11.74 Peter Wharton
Susan Margaret Frodsham b. 14.3.55 m. 22.7.78 David Harrison
Richard James McKee b. 3.7.74
Jennifer Dawn McKee b. 22.5.76
Sarah Jane Frodsham b. 7.11.77
Colin John Wharton b. 1.3.78

WILLIAM JAMES FRODSHAM FAMILY TREE

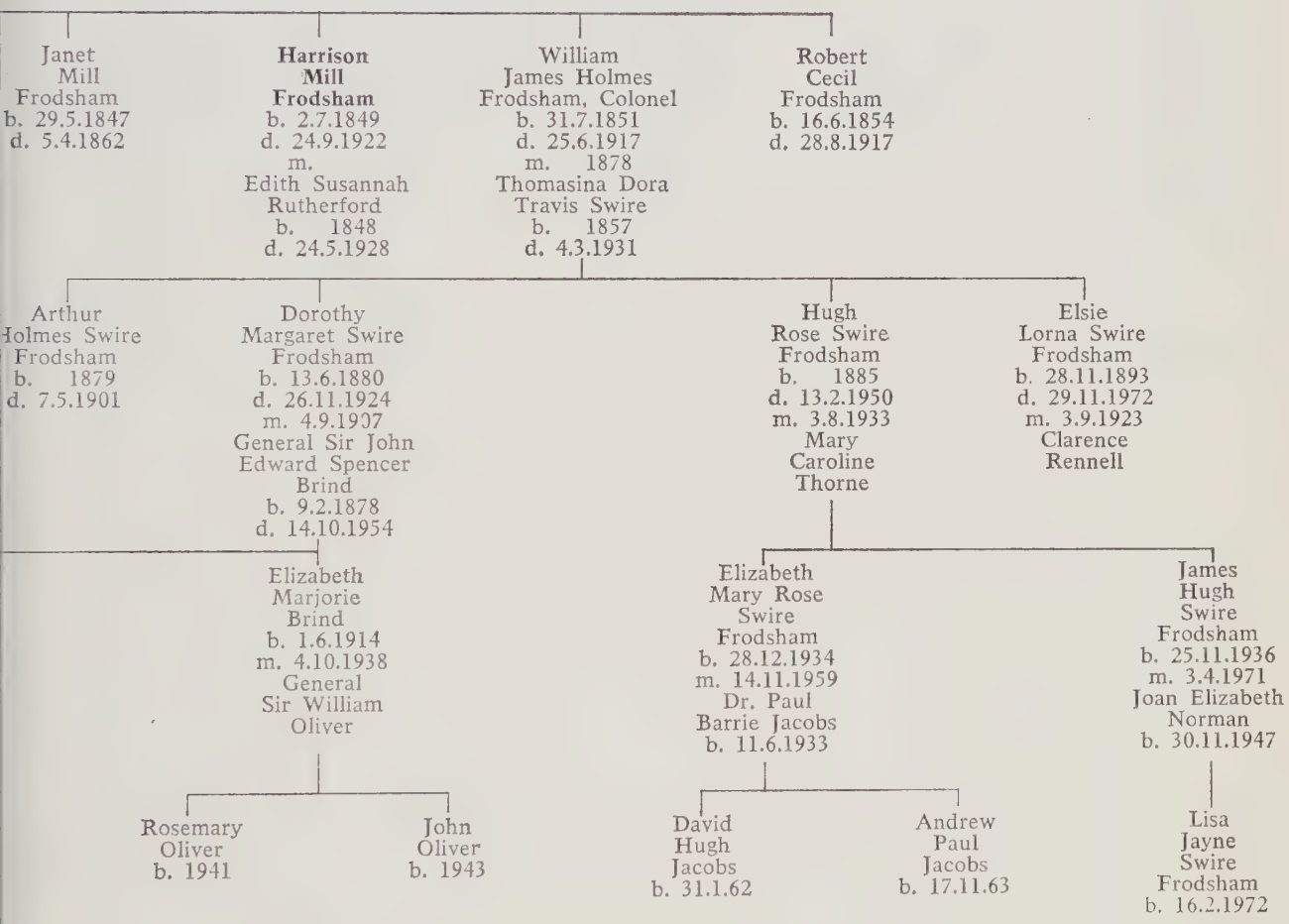

John Mill Frodsham, Dr. b. 6.2.1835 d. 12.5.1907 m. 30.1.1866 Theresa D'Iffanger d. 29.3.1920
Effie Theresa Frodsham b. 29.11.1867 d. .12.1962 m. 1894 Sir Thomas Frederick Dawson Miller, K.C. (Judge)
Mabel Frodsham b. 23.11.1868
Augusta Maria Beatrice (Boysie) Frodsham b. 18.5.18 d. m. Arnold Henry Poole b. 9.6.18
Vera Dawson Miller b. 18.8.1895 m. 1947 Donald MacAndrew
Hilda Dawson Miller b. 16,2,1900 m. Simon Harcourt Smith
Marion Ella Poole b. 1894
John Sanderson Poole b. 1896 d. 1966 m. Audrey Bickmore
Raymond Poole b. 1900 d. 1916
Olive Poole b .1903
Alice Beatrice Poole b. 1905 d. 1947
Hugh Aleck Poole b. 1910 d. 1944 m. Joan Furber
Pamela Poole b. 1912
Charles Harcourt Smith, Major b. 3.1942
Sally Poole
Nicola Poole

WILLIAM JAMES FRODSHAM FAMILY TREE

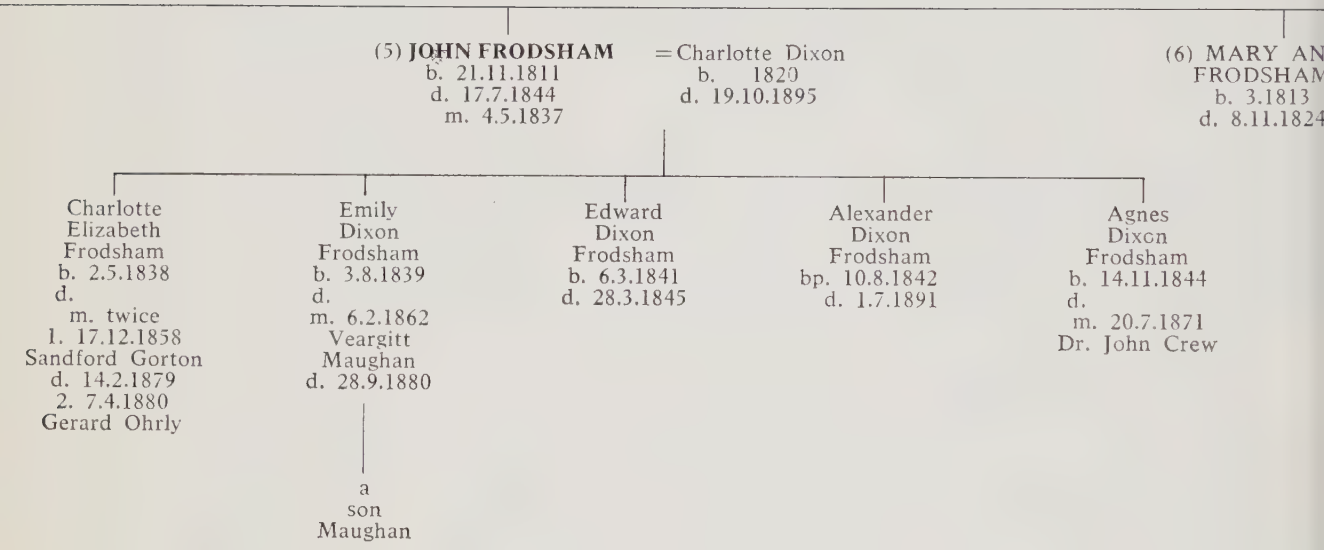

Marguerite Marion (Daisy) Frodsham b. m. Charles Moggridge
Leigh Duncan Mill Frodsham b. d. 9.11.39
Sybil Frodsham d. 1962
Frederick Frodsham S. Africa
Lilian Frodsham
Angela Moggridge b. m. Henry Stisted
Pan Moggridge b. m. twice 1. Diana Blunt. 2.
Charles Stisted b. 1935
John Stisted b. 1937
Christopher Stisted b. 1943
Peter Stisted b. 1945
Felicity Moggridge b. 25.3.43 m. Charles Stisted
Caroline Moggridge b. 15.9.45 m. David Watson
Anna Moggridge b. 24.4.48


(4) CHARLES FRODSHAM
b. 15.4.1810
m. 28.4.1834
d. 11.1.1871
=
Elizabeth Mill
b. 1813
d. 3.7.1879
Charles Mill Frodsham
b. 20.7.1836
d. 23.9.1881
m. 13.1.1869
Susan Cockett Tytherleigh
b. 6.11.1846
Frances Mill Frodsham
b. 9.4.1838
d. 24.10.1868
Hannah Frodsham
b. 7.12.1839
d.
m. 16.4.1868
George John Moore
b. 29.5.1838
Euphemia (Effie) Mill Frodsham
b. 14.12.1841
d.
m. 1875
Henry de Parney Rennick, Colonel.
b. 1839
d. 21.12.1893
George Graham Moore
b. 13.12.1868
d. 16.12.1868
Alice Maud Emma Moore
b. 13.2.1870
Frances Elizabeth Moore
b.
Effie Rennick
b. 24.4.1878
James Lindesay Brind
Brigadier
b. 29.8.1909
m. 21.8.1946
Evelyn Elizabeth Mann
Peter Holmes Walter Brind
Major General
b. 16.2.1912
m. 4.7.1942
Patricia Stewart Walker
Christopher Markham Brind
b. 23.1.49
Robin Peter Brind
b. 1943
m. 9.10.71
Janet Carter Kemp
Michael John Stewart Brind
b. 1946
Nigel Patrick Frodsham Brind
b. 1951
Sophie Elizabeth Brind
b. 30.1.75
Anna Patricia Brind
b. 30.7.77

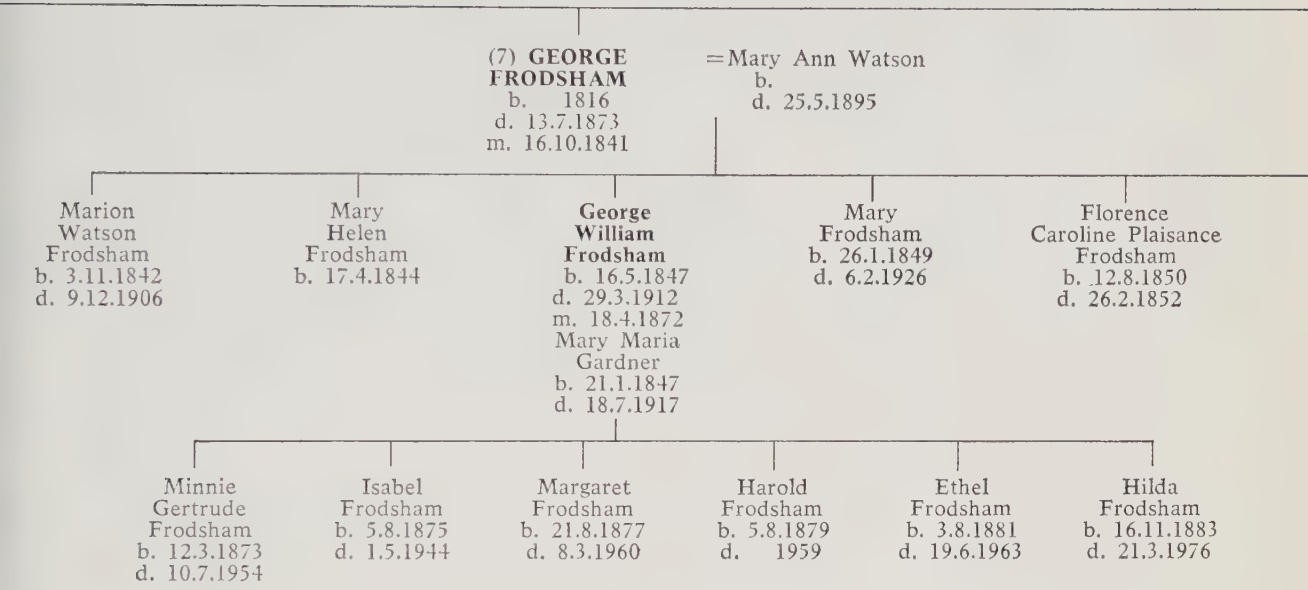
WILLIAM JAMES FRODSHAM FAMILY TREE

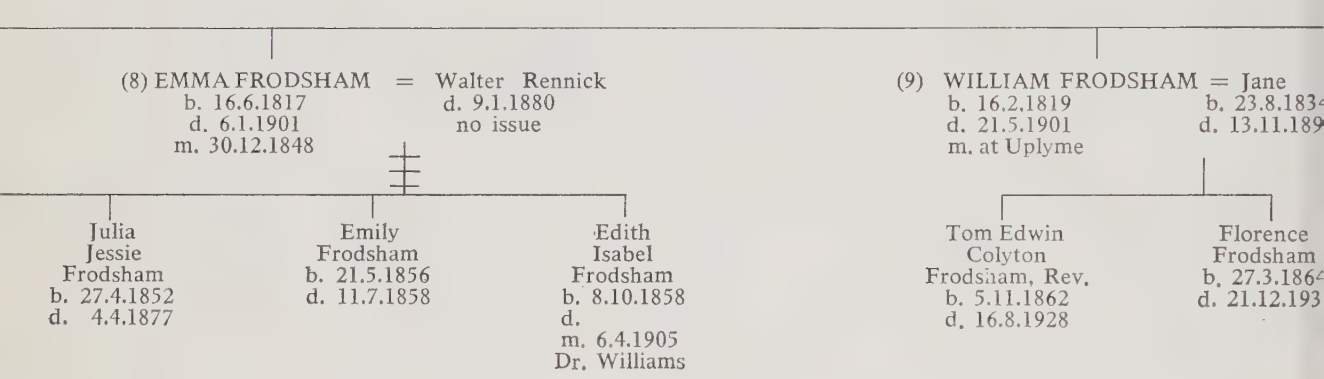

Janet Mill Frodsham b. 29.5.1847 d. 5.4.1862
Harrison Mill Frodsham b. 2.7.1849 d. 24.9.1922 m. Edith Susannah Rutherford b. 1848 d. 24.5.1928
William James Holmes Frodsham, Colonel b. 31.7.1851 d. 25.6.1917 m. 1878 Thomasina Dora Travis Swire b. 1857 d. 4.3.1931
Robert Cecil Frodsham b. 16.6.1854 d. 28.8.1917
Arthur Holmes Swire Frodsham b. 1879 d. 7.5.1901
Dorothy Margaret Swire Frodsham b. 13.6.1880 d. 26.11.1924 m. 4.9.1907 General Sir John Edward Spencer Brind b. 9.2.1878 d. 14.10.1954
Hugh Rose Swire Frodsham b. 1885 d. 13.2.1950 m. 3.8.1933 Mary Caroline Thorne
Elsie Lorna Swire Frodsham b. 28.11.1893 d. 29.11.1972 m. 3.9.1923 Clarence Rennell
Elizabeth Marjorie Brind b. 1.6.1914 m. 4.10.1938 General Sir William Oliver
Elizabeth Mary Rose Swire Frodsham b. 28.12.1934 m. 14.11.1959 Dr. Paul Barrie Jacobs b. 11.6.1933
James Hugh Swire Frodsham b. 25.11.1936 m. 3.4.1971 Joan Elizabeth Norman b. 30.11.1947
Rosemary Oliver b. 1941
John Oliver b. 1943
David Hugh Jacobs b. 31.1.62
Andrew Paul Jacobs b. 17.11.63
Lisa Jayne Swire Frodsham b. 16.2.1972

WILLIAM JAMES FRODSHAM FAMILY TREE



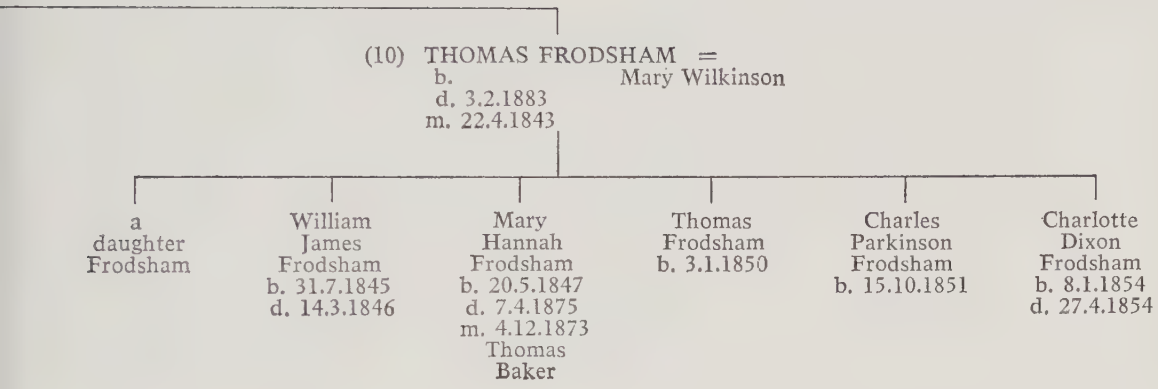
WILLIAM JAMES FRODSHAM FAMILY TREE





Correction. Delete the line below " Emma Frodsham ".

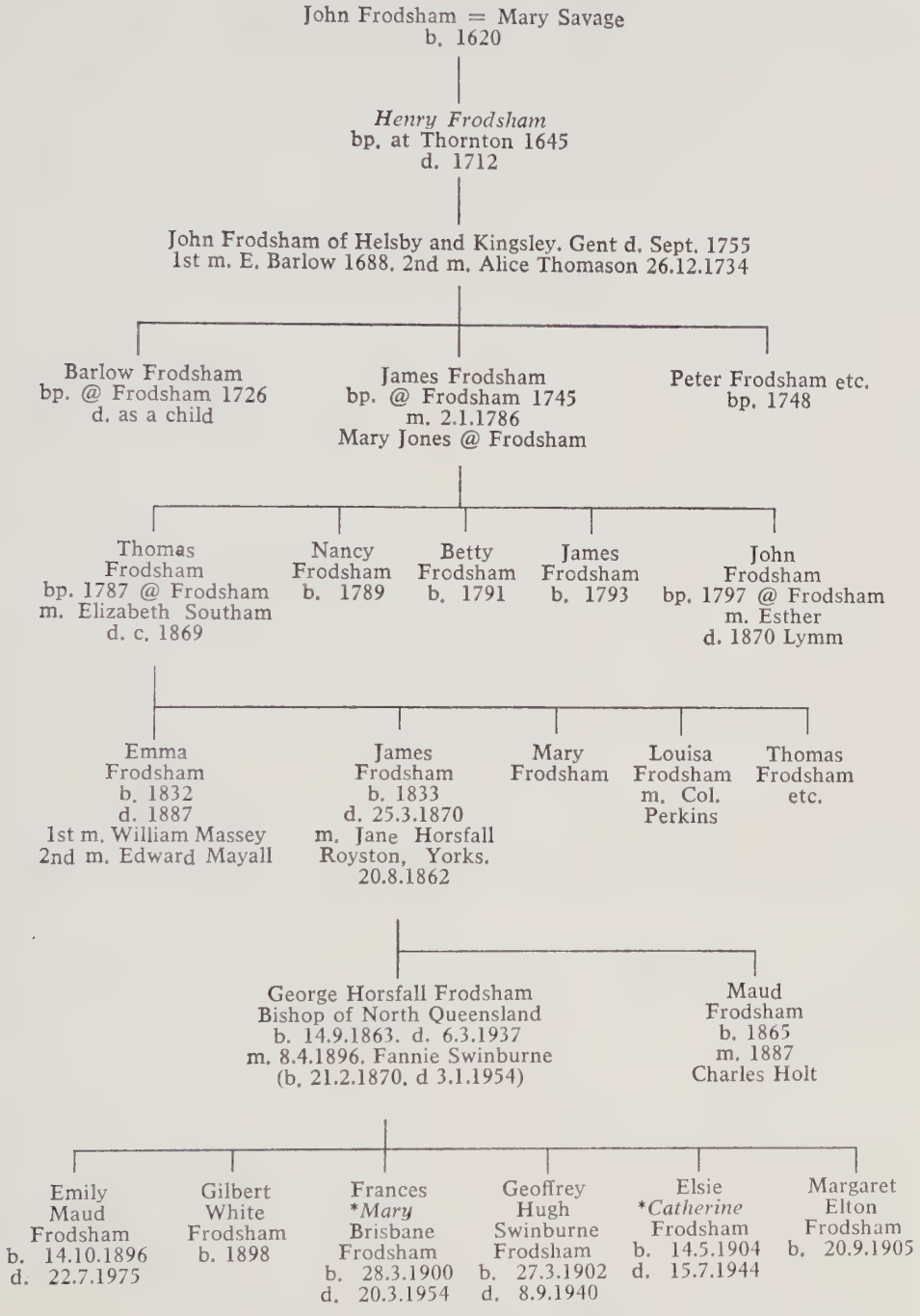
WILLIAM JAMES FRODSHAM FAMILY TREE


(10) THOMAS FRODSHAM =
b.
d. 3.2.1883
m. 22.4.1843
Mary Wilkinson
a daughter Frodsham
William James Frodsham b. 31.7.1845 d. 14.3.1846
Mary Hannah Frodsham b. 20.5.1847 d. 7.4.1875 m. 4.12.1873 Thomas Baker
Thomas Frodsham b. 3.1.1850
Charles Parkinson Frodsham b. 15.10.1851
Charlotte Dixon Frodsham b. 8.1.1854 d. 27.4.1854

Note. In these family trees, where some of the dates of birth and death are unknown, spaces have been left for their inclusion, should they come to light.

APPENDIX IV

GEORGE HORSFALL FRODSHAM FAMILY TREE

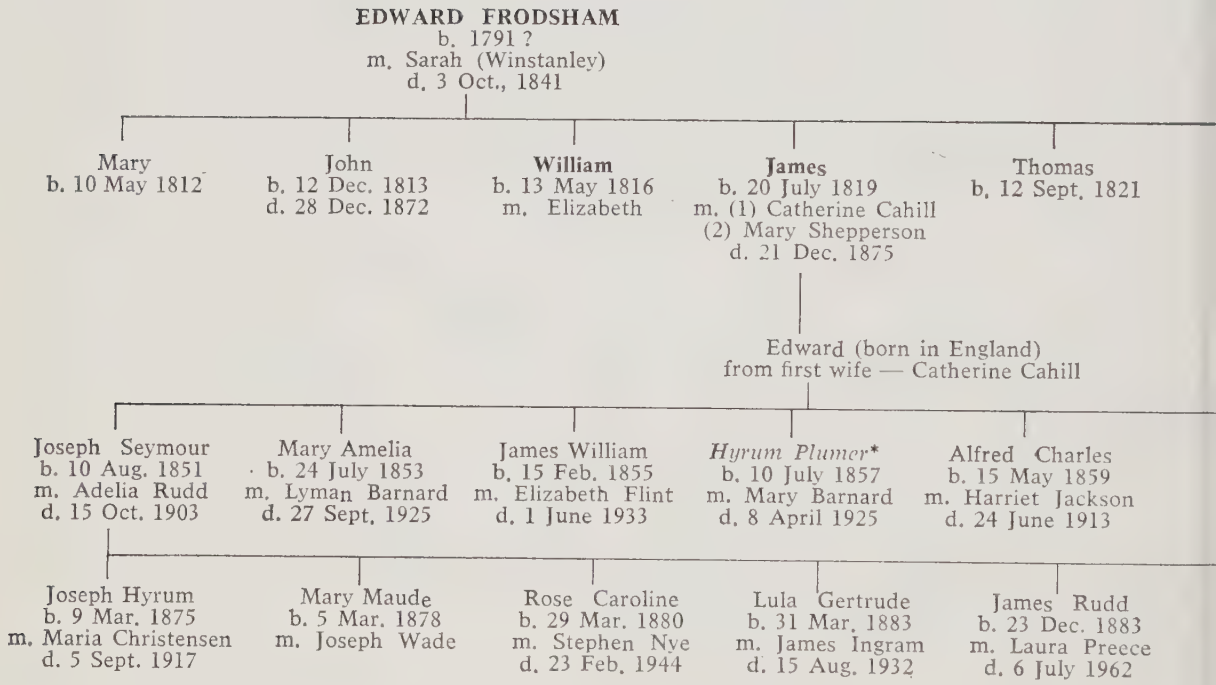


*known as "Mary" and "Catherine"

APPENDIX V

EDWARD FRODSHAM'S FAMILY TREE

AN AMERICAN BRANCH



*This is the relative who claimed the money in England.

Mary
b. 25 Dec. 1823

George
b. 25 Jan. 1827
d. 1910

Rose
b. 20 Feb. 1861

Albert Norman
b. 13 Oct. 1861
d. 18 Feb. 1866

Franklin David
b. 13 Nov. 1864
d. 13 Mar. 1866

Erastus
b. 23 Oct. 1885
m. Edith Draper
d. 30 June 1945

Stella Lucinda
b. 19 Apr. 1888
m. Jess Keller
d. 14 May 1953

Frank Le Roy
b. 11 Oct. 1890
m. Mary Priest
d. 7 Feb. 1923

Esther Pearl
b. 14 June 1892
m. Willard Keith
d. 15 Jan. 1962

Leland Earl
b. 10 June 1895
m. Sharlotte Grogan
d. 9 Mar. 1954

Alta Adelia
b. 6 Feb. 1899
m. Guy Hansen
d. 31 May 1958

Ellis Dale
b. 12 Jan. 1912
m. Erma Swain

Herold
b. 9 Aug. 1913
d. 9 Aug. 1913

Cecil Erastus
b. 31 Jan. 1915
m. Mary Wilkinson

James Monte
b. 8 Sept. 1919
m. Vivian Charroin
d. Dec. 1974

Vaughn Dillworth
b. 31 Mar. 1922
m. Audrey Bell

Erma Jean

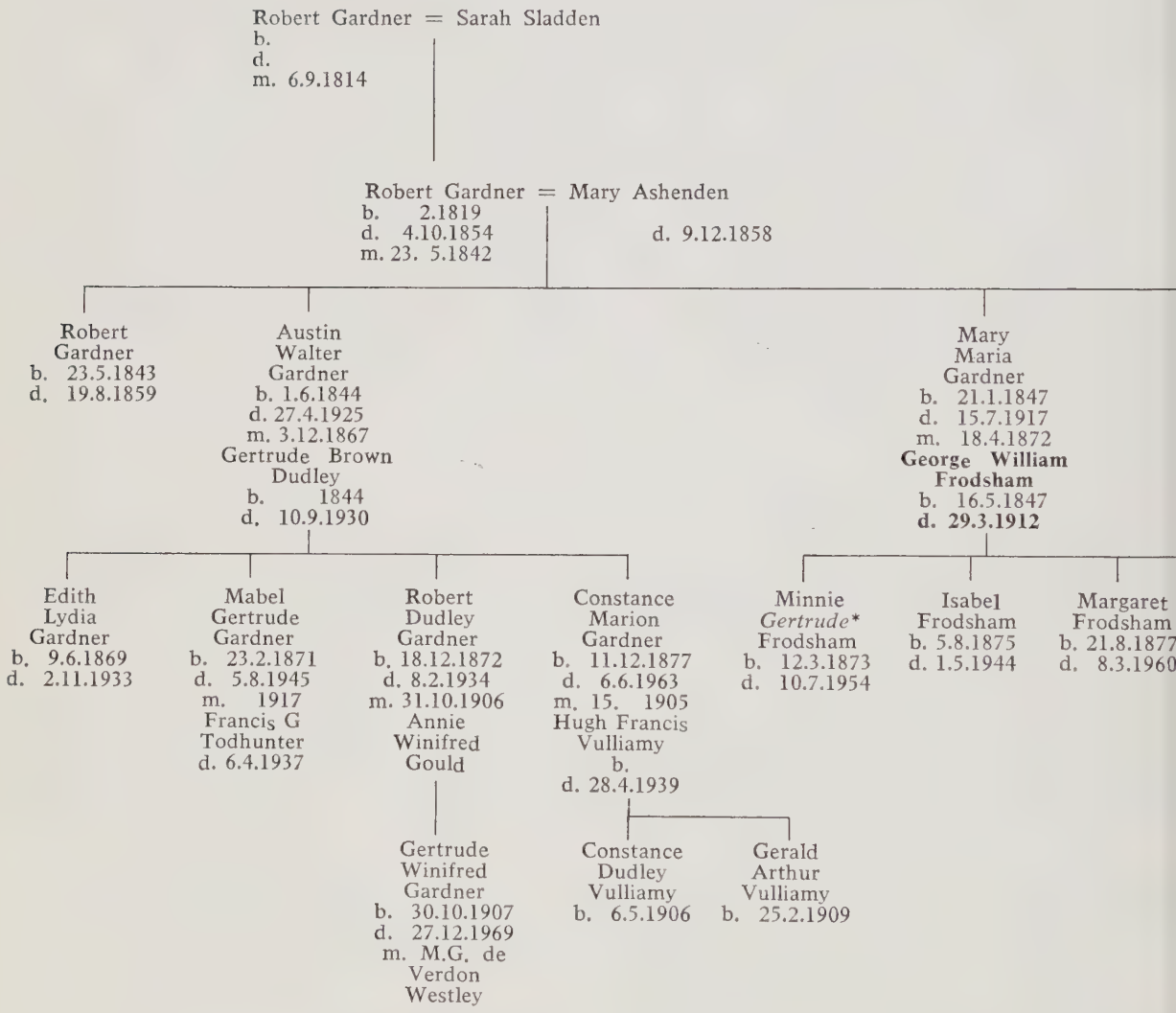
Dale Gary

Carol Ann
m. 1976
William
Gregory
Otteson

John Swain

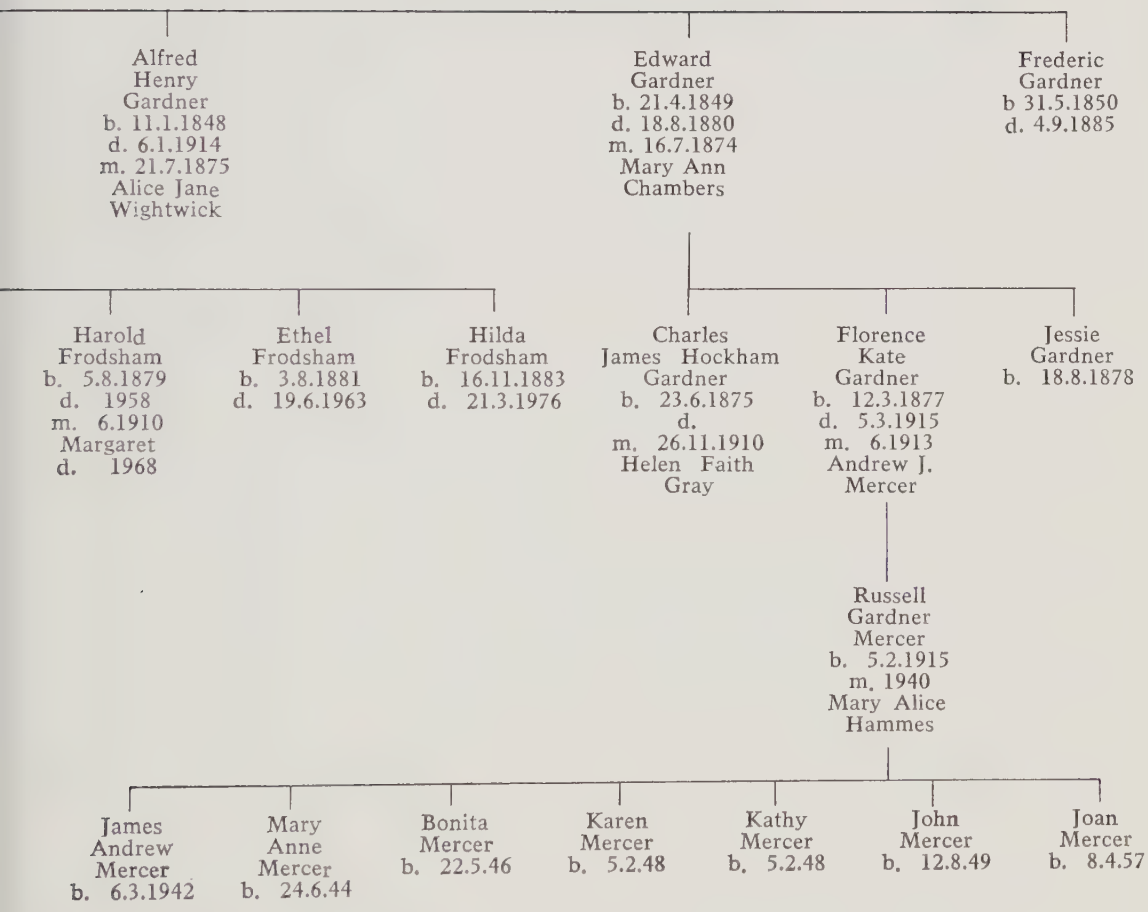
APPENDIX VI

MARY MARIA FRODSHAM'S FAMILY TREE



* Known as "Gertrude"

MARY MARIA FRODSHAM'S FAMILY TREE


Alfred Henry Gardner b. 11.1.1848 d. 6.1.1914 m. 21.7.1875 Alice Jane Wightwick
Edward Gardner b. 21.4.1849 d. 18.8.1880 m. 16.7.1874 Mary Ann Chambers
Frederic Gardner b 31.5.1850 d. 4.9.1885
Harold Frodsham b. 5.8.1879 d. 1958 m. 6.1910 Margaret d. 1968
Ethel Frodsham b. 3.8.1881 d. 19.6.1963
Hilda Frodsham b. 16.11.1883 d. 21.3.1976
Charles James Hockham Gardner b. 23.6.1875 d. m. 26.11.1910 Helen Faith Gray
Florence Kate Gardner b. 12.3.1877 d. 5.3.1915 m. 6.1913 Andrew J. Mercer
Jessie Gardner b. 18.8.1878
Russell Gardner Mercer b. 5.2.1915 m. 1940 Mary Alice Hammes
James Andrew Mercer b. 6.3.1942
Mary Anne Mercer b. 24.6.44
Bonita Mercer b. 22.5.46
Karen Mercer b. 5.2.48
Kathy Mercer b. 5.2.48
John Mercer b. 12.8.49
Joan Mercer b. 8.4.57

APPENDIX VII

BUSINESS PREMISES AND TITLES

William Frodsham.
1759 Kingsgate Street.
1796 - 1807 12 Kingsgate Street, Red Lyon Square, Bloomsbury.

John Frodsham.
1807 - 1808 12 Kingsgate Street.

Frodsham & Baker.
1808 - 1809 12 Kingsgate Street.

John Frodsham.
1809 - 1824 12 Kingsgate Street.
1825 - 1834 33 Gracechurch Street.

John Frodsham & Son.
1834 - 1837 33 Gracechurch Street.
1838 - 1853 31 Gracechurch Street.

Frodsham, Son & Co.
1854 31 Gracechurch Street.

Frodsham & Baker.
1854 - 1863 31 Gracechurch Street.

George Edward Frodsham.
1864 - 1881 31 Gracechurch Street.

G. E. Frodsham & Co.
1882 - 1888 31 Gracechurch Street.

G. E. Frodsham & Co. Ltd.
1888 - 1901 31 Gracechurch Street.

Parkinson & Frodsham. (London)
1801 - 1890 4 Change Alley, Cornhill.
1891 - 1892 16 Queen Victoria Street.
1893 - 1895 35 Royal Exchange.
1896 - 1905 15B Royal Exchange.
1906 - 1947 5 Budge Row.

Parkinson & Frodsham. (Liverpool)
1828 - 1831 54 Castle Street.
1831 - 1834 38 Castle Street.

Henry Frodsham.
1834 - 1838 38 Castle Street.
1838 - 1844 40 Castle Street.
1844 - 1856 17 South Castle Street.

Frodsham & Keen.

1856 - 1878 17 South Castle Street.
1878 - 1893 9 St. George's Crescent.
1894 - 1935 31 South Castle Street.

Henry Herbert Frodsham.

1881 - 1884 33 Piccadilly, London.
1886 - 1894 7 St. Mary's Street, Bedford.
1894 - 1915 3 Harper Street, Bedford.

Charles Frodsham.

1834 - 1836 Barossa Place, Islington.
1837 - 1838 12 Finsbury Pavement.
1838 - 1843 7 Finsbury Pavement.

Arnold & Frodsham.

1844 - 1857 84 Strand.

Charles Frodsham.

1858 - 1884 84 Strand.

Charles Frodsham & Co.

1885 - 1893 84 Strand.

Charles Frodsham & Co. Ltd.

1894 - 1895 84 Strand.
1896 84 Strand, and 115 New Bond Street.
1897 - 1902 115 New Bond Street, and 11 Duke Street.
1903 - 1914 115 New Bond Street.
1915 27 South Molton Street, W.1.
1916 - 1919 27 South Molton Street, and 78 Davies St. Grosvenor Sq.
1920 - 1941 27 South Molton Street.
1942 - 1946 62 Beauchamp Place
1947 - 1958 173 Brompton Road
1959 - 1962 173 Brompton Road, and 31 & 33 Palmer Street.
1963 - 1973 173 Brompton Road
1974 47 South Audley Street

APPENDIX VIII

CHRONOLOGY AS REGARDS NUMBERING

	Watches	Marine	Clocks
William Frodsham	568 - 2579		
William Frodsham & Son	2130		
Frodsham & Baker	1236	2503	
Frodsham, Gracechurch St.	266 - 2420	501	
G. E. Frodsham, Gracechurch St.	2572 - 3070	2983 - 6154	
Frodsham, Gracechurch St.	3194 - 4189	4089	
Frodsham & Son or **Frodsham**	4400 - 7044		
Frodsham & Baker	7431 - 8240	6048 - 6242	
G. E. Frodsham	8559 - 59212	6501 - 7004	
Arnold & Frodsham	2379 - 9737	1529 - 1535	1497
	12692 - 15897		
	36283		
	100511		
Charles Frodsham	2173	1614 - 5049	847 - 2460
	5710	10033	19352
	6825	Paris	19951 - 20417
	8645		
	8890		
	9950		
	10092		
	60637		
	101397		

From the above it will be seen that sometimes these watches were in the names of Arnold & Frodsham and sometimes in the name of Charles Frodsham in these series. The same thing occurs in the next group which commences with an ' O '.

Charles Frodsham or			
Arnold & Frodsham	01054 - 01893		
Charles Frodsham	01914 - 010321		
Parkinson & Frodsham	113 - 12278	105 - 3943	
(Verge)	14989		
	29890	730 / 17290	
	34752	dated 1832	
	51729		
? Swiss	381477		
William Frodsham, Liverpool	1784		
Parkinson & Frodsham			
Liverpool	1875 - 2014		

Henry Frodsham, Liverpool	3093	1991 - 2741
		4950 - 4956
Frodsham & Keen, Liverpool	71/9019	2798 - 4080
		6148
		13270
Henry Frodsham, London	20377	
	46267	

DATING WATCHES BY THEIR HALL MARKS

William Frodsham,	Red Lyon Square		No. **568**	A.D. 1766
Frodsham	Gracechurch St.		**266**	1820
G. E. Frodsham	,,		**2505**	1868
,,	,,		**7230**	1873
,,	,,		**10243**	1875
,,	,,		**14024**	1877
,,	,,		**15112**	1882
Frodsham,	London		**16003**	1863
,,	,,		**24222**	1886
G. E. Frodsham			**59212**	1887
			67003	1893

Arnold & Frodsham

2838	1854	**8742**	1856
3058	1846	**8890**	1856
6448	1845	**9348**	1857
6551	1845	**9651**	1858
6571	1846	**9683**	1865
7167	1851	**9737**	1858
7172	1851	**12867**	1862
7418	1852	**14062**	1862
7464	1852	**15185**	1863
7888	1853	**36283**	1848
8336	1854	**101397**	1860
8484	1860		

Charles Frodsham	84 Strand	**2173**	1862
,,	,,	**5710**	1877
,,	,,	**6825**	1878
,,	Brompton Road	**10092**	1947
,,	84 Strand	**101397**	1860
,,	,,	**01289**	1860
,,	,,	**01378**	1859
,,	,,	**01505**	1860
Arnold & Frodsham	,,	**01669**	1861
,,	,,	**01675**	1861

Charles Frodsham 84 Strand

01757	1863		**04569**	1872	
02012	1861		**04674**	1872	
02037	1862		**05354**	1875	
02140	1860		**05419**	1875	
02173	1862		**05501 - 09315**	Appendix XI	
02184	1863		**09365**	1910	
02408	1865	113 New Bond St.	**09517**	1911	
02413	1863		**09551**	1913	
02423	1865		**09572**	1915	
02631	1880		**09655**	1913	
02669	1865		**09692**	1917	
02819	1861		**09756**	1917	
03301	1865		**09759**	1912	
03359	1867		**09775**	1903	
03418	1866	27 South Molton St.	**09819**	1923	
03519	1867		**09863**	1921	
03523	1866		**09867**	1922	
03524	1866		**09874**	1921	
03526	1866		**09936**	1923	
03529	fecit 1868		**010090**	1890	
03530	fecit 1867		**010132**	1881	
03644	1889		**010173**	1892	
03688	1886		**010180**	1893	
03739	1868		**010295**	1924	
03800	1875		**010321**	1932	
04061	1870				

Parkinson & Frodsham

Number	Date		
324	1817	**1875**	1829 L
344	1805	**1963**	1830
478	1804	**2014**	1829 L
541	1854	**2709**	1837
620	1819	**4000**	1852
654	1823	**4436**	1856
743	1819	**4479**	1857
948	1823	**4530**	1858
1102	1824	**5115**	1874
1292	1820	**5301**	1867
1625	1825	**6009**	1895
1801	1827	**6292**	1880

L = Liverpool

6416	1882
7114	1896
7269	1904
7457	1915
51729	1905
381477	1885

Frodsham, Liverpool

3093	1853

Henry Frodsham, London

20377	1879

APPENDIX IX

PARKINSON & FRODSHAM
MANUFACTURING

The following extracts have been made from the only workbook available. The unmentioned intermediate numbers have no name of manufacturer and these watches would appear to have been made on the premises, since the details of the cost of each process of manufacture are given (unfortunately in code), but no names are mentioned. However, as already pointed out the code has been solved.

Sometimes the workbook only gives the initials of the manufacturer. The following is my interpretation of the names inferred by these initials :

J.A. = John Adams
J.H. = J. Hewitt
F.M. = F. Murray
N. = Nicole
N - e & Co. = Nicole & Co.
N. & N. = Nicole & Nielsen
V - r = Vivier
A.P.W. = A. P. Walsh
P.W. = P. Walsh
W - h = Walsh
P.W - h = P. Walsh

5801 - 5809	Murray	1872	**5868 - 5869**	Walsh	1873
5810 - 5811	House	1872	**5870**	Murray	1873
5812	Nelson	1872	**5871**	Langton	1873
5813 - 5815	House	1872	**5874**	Murray	1873
5816	Carley	1872	**5877**	Murray	1873
5818	Vivier	1872	**5878 - 5883**	Walsh	1873
5821 - 5825	Murray	1872	**5885**	W. Bex	1873
5826	Carley	1872	**5894 - 5895**	Golay	1873
5830 - 5831	Carley	1872	**5911 - 5912**	Vivier	1873
5833	House	1872	**5913**	Golay	1873
5838	Hewitt	1872	**5914 - 5915**	Murray	1874
5842 - 5843	Audemars	1872	**5916 - 5917**	P. W - h	1874
5844	N - e & Co.	1872	**5918 - 5920**	Carley & Co.	1874
5845	V - r	1872	**5921**	Walsh	1874
5851 - 5852	W - h	1872	**5922**	Carley & Co.	1874
5859 - 5861	F. Murray	1872	**5923**	Isaac	1874
5865 - 5866	Murray	1873	**5931**	Nicole & Capt	1874
5867	Carley	1873	**5932**	Walsh	1874

5934 - 5935	Hewitt	1874
5939 - 5942	Walsh	1874
5943 - 5945	Hewitt	1874
5952 - 5953	Hewitt	1874
5954	Vivier & Hewitt	1874
5955	Isaaca	1874
5960	Carley	1874
5961 - 5973	Murray	1874
5974	Muller	1874
5975 - 5976	Nicole & Capt	1874
5977 - 5978	Carley	1874
5979 - 5981	Isaac	1874
5982	Poole	1874
5983	H. Good	1874
5989	Isaac	1874
5993	Vivier	1874
5994 - 5997	Murray	1874
6002	Murray	1874
6003	Walsh	1874
6004 - 6006	Murray	1874
6007 - 6012	Walsh	1875
6018 - 6019	Murray	1875
6021	Muller	1875
6022 - 6023	F. Murray	1875
6053 - 6058	P. W - h	1875
6063	Walsh	1875
6079	Reymond	1875
6084 - 6085	W - h	1876
6086 - 6091	Murray	1875
6094 - 6097	W - h	1876
6099 - 6100	Murray	1876
6101 - 6102	F. M.	1876
6148 - 6156	Walsh	1876
6161	Phillips & Phillip	1876
6177 - 6179	White, Coventry	1876
6180 - 6181	Walsh	1876
6188 - 6189	W - h	1876
6192	Carr Saunders	1877
6195 - 6198	P. W.	1877
6204	Nicole & Capt	1877
6205 - 6210	F. M.	1877
6215 - 6218	A. P. W.	1877
6223 - 6226	Murray	1877
6227	Nicole & Capt	1878
6230	Nicole & Capt	1878
6231 - 6232	Murray	1878
6242	Clerk	1878
6243	N & N	1878
6244	Poole	1878
6245 - 6248	F. M.	1879
6249	P.W. - h	1879
6259 - 6260	Murray	1879
6263 - 6266	Walsh	1880
6270	Nicole & Nielsen	1880
6271	Walsh	1880
6276 - 6279	J. Player, Coventry	1880
6280 - 6292	? Player	1880
6293 - 6294	J. Adams	1880
6295 - 6296	Walsh	1880
6297	Nicole & Nielsen	1880
6299 - 6300	J. Adams, Coventry	1881
6307	Carley & Co.	1881
6308	McCabe	1881
6309 - 6312	Player, Coventry	1881
6313	Walsh	1881
6317	Player, Coventry	1881
6319	John Adams	1881
6320 - 6321	Webber	1881
6324 - 6326	Adams	1881
6327	J. Player	1881
6328	Nicole & Nielsen	1881
6331	Walsh	1881
6332 - 6333	Nicole Nielson & Co.	1881
6334 - 6336	A. P. W.	1881
6337 - 6348	J. Adams	1881
6351	Nicole Nielsen	1881
6352 - 6356	Player	1881
6357 - 6359	J. Adams	1881
6361 - 6362	J. Adams	1881
6363	J. Player	1881
6364	J. Adams	1881
6365	Neill & Herburg	1881
6366	Clark & Son	1881
6368	Nicole Nielsen	1881
6369	J. Adams	1881

6370 - 6383	J. Player	1882
6384	Adams	1882
6387	J. Adams	1882
6393 - 6394	J. A.	1882
6397 - 6401	John Hewitt, Coventry	1882
6402	J. Adams	1882
6403 - 6406	Walsh	1882
6407 - 6408	Player	1882
6409 - 6410	Hewitt	1882
6411	Nicole Nielsen	1882
6412	Player	1882
6413 - 6414	Adams	1882
6415	J. T. Hewitt, 4 Spencer St.	1882
6416 - 6417	Player	1882
6418	J. Adams	1882
6419 - 6420	Reymond	1882
6421 - 6426	J. Player	1882
6427	Hewitt	1882
6428 - 6430	Walsh	1882
6431	J. Hewitt	1882
6432 - 6433	Nicole Nielsen	1882
6434 - 6435	House	1882
6436	Player	1882
6437 - 6438	Adams	1882
6439	A. P. W.	1882
6452 - 6453	J. Hewitt	1882
6458 - 6460	Player	1883
6461 - 6462	A. P. Walsh	1883
6463 - 6464	Adams	1883
6465	Nicole Nielsen & Co.	1883
6466	Muller	1883
6468 - 6484	Player	1883
6485 - 6486	J. Hewitt	1883
6487 - 6489	Reymond	1883
6490 - 6491	A. P. Walsh	1883
6492	J. Hewitt	1883
6493 - 6494	J. Adams	1883
6495 - 6497	J. Player	1883
6498	Nicole Nielsen	1883
6499 - 6500	Hewitt, Coventry	1883
6501 - 6503	A. P. Walsh	1883
6504	Player	1883
6505	Adams	1883
6512	Hewitt	1883
6513	Nicole Nielsen	1883
6514	J. Adams	1883
6515	A. P. Walsh	1883
6516	Nicole & Nielsen	1883
6517 - 6518	J. Adams	1883
6521 - 6523	Little	1883
6524 - 6541	Player	1883
6542	Audemars	1883
6543	Clarke, Goswell Rd.	1883
6544	Webber	1883
6546 - 6547	Little & Co.	1883
6549 - 6550	Hewitt, Coventry	1884
6551	G. Little	1884
6558 - 6563	J. Hewitt, Coventry	1884
6564 - 6576	Hewitt, Holyhead Rd.	1884
6577	G. Little	1884
6578	J. Adams	1884
6580	J. Hewitt	1884
6581	Nicole & Nielson	1884
6582	J. Little	1884
6583 - 6586	J. Hewitt	1884
6587	Adams	1884
6588	Player	1884
6589 - 6592	J. Hewitt	1884
6593	J. Player	1884
6594 - 6596	J. Hewitt	1884
6597	Little	1884
6598	J. Hewitt	1884
6599	Nicole Nielsen	1884
6600 - 6603	Hewitt	1884
6604 - 6607	J. Adams	1884
6609 - 6613	A. P. Walsh	1884
6614 - 6615	Player	1884
6616 - 6626	J. Hewitt	1884
6628 - 6629	Little	1884
6630	A. P. Walsh	1884
6631 - 6633	N.	1884
6634 - 6635	Hewitt	1885

6636	J. Adams	1885
6637 - 6638	J. Player	1885
6641	Little	1885
6642 - 6643	Player	1885
6644	Hewitt	1885
6645	Little	1885
6647 - 6652	Hewitt	1885
6653 - 6658	Player	1885
6660	A. P. Walsh	1885
6661 - 6662	J. Hewitt	1885
6663 - 6664	Little	1885
6665	Adams	1885
6666	Little	1885
6667	J. Hewitt	1885
6668 - 6669	Little	1885
6671	Little	1885
6672 - 6687	Player	1885
6688 - 6690	J. Hewitt	1885
6691	N & N	1885
6692	J. A.	1885
6693 - 6694	Hewitt	1885
6695	Walsh	1885
6696	Little	1885
6697 - 6699	J. Hewitt	1885
6701 - 6707	Little	1886
6708	N & N	1886
6709 - 6711	Little	1886
6715	Adams	1886
6716 - 6717	Tesser	1886
6718 - 6721	Little	1886
6722 - 6730	J. Hewitt	1886
6731	Little	1886
6732	Adams	1886
6734 - 6735	J. Hewitt, Coventry	1886
6737 - 6739	J. Player	1886
6740 - 6742	A. P. Walsh	1886
6743	Hewitt	1886
6744	A. P. W.	1886
6745 - 6748	Little	1886
6749 - 6750	Player	1886
6751 - 6753	Little	1886
6754	N & N	1886
6755	J. Adams	1886
6757 - 6759	J. Hewitt	1886
6760	A. P. Walsh	1886
6761 - 6762	Little	1886
6763	Adams	1886
6764	J. Hewitt	1886
6765 - 6766	Little	1887
6767	J. Hewitt	1887
6768 - 6770	J. Player	1887
6771	J. H.	1887
6772 - 6775	Little	1887
6776	Nicole & Nielsen	1887
6777 - 6781	J. A.	1887
6782	N & N	1887
6783 - 6785	Little	1887
6786	Adams	1888
6787	Ashley	1888
6788 - 6789	Adams	1888
6790	Walsh	1888
6793 - 6796	J. Adams	1888
6797	Little	1888
6798	J. Player	1888
6799	Smythson	1888
6800	Hewitt	1888
6801	Little	1888
6802 - 6803	Adams	1888
6804	Hewitt	1888
6805 - 6808	J. Adams	1888
6809	Nicole & Nielsen	1888
6810	Rotherham	1888
6812	Little	1888
6813 - 6814	J. Hewitt	1888
6815 - 6821	Adams	1888
6822	A. P. Walsh	1888
6823	J. Hewitt	1889
6824 - 6826	Adams	1889
6827 - 6832	J. Hewitt	1889
6833	Adams	1889
6834 - 6835	J. Hewitt	1889
6836	Adams	1889
6837	J. H.	1889
6838 - 6841	Little	1889
6842 - 6848	J. A.	1889
6849 - 6850	Hewitt	1889
6851 - 6852	Adams	1889

6853 - 6855	J. Hewitt	1889
6856 - 6857	A. P. Walsh	1889
6858 - 6860	Adams	1889
6861 - 6862	Smythson	1889
6863 - 6864	Little	1889
6867	Isaacs	1889
6868 - 6869	Tripplin, Rotherham watches	1889
6870	Smythson	1889
6871	Hewitt	1889
6872 - 6873	Adams	1889
6874	Golay	1889
6875	Adams	1889
6876	Tripplin	1890
6877	Adams	1890
6878 - 6879	Little	1890
6880 - 6881	Adams	1890
6882	Player	1890
6883 - 6885	J. Adams	1890
6887	Adams	1890
6888	Nicole & Nielsen	1890
6889 - 6890	Walsh	1890
6891	J. Player	1890
6892	Adams	1890
6893 - 6895	Little	1890
6896 - 6897	Adams	1890
6898	Hewitt	1890
6899 - 6900	Tripplin, Rotherham	1890
6901 - 6905	J. Adams	1890
6906	J. Player	1890
6907	J. Adams	1890
6908	Little	1890
6909 - 6910	Adams	1890
6911	Little	1890
6912	Adams	1890
6914	J. Adams	1890
6916 - 6921	J. Adams	1891
6922	J. Hewitt	1891
6923	J. Adams	1891
6924 - 6927	J. Hewitt	1891
6928 - 6933	Adams	1891
6934 - 6935	Little	1891
6936 - 6939	J. Adams	1891
6940	Hewitt	1891
6942 - 6944	J. Adams	1891
6951	J. Adams	1891
6955 - 6972	J. Adams	1892
6975	Adams	1892
6977 - 6980	Adams	1892
6983	J. Hewitt	1892
6984	Adams	1892
6985	Smythson	1892
6986 - 6991	Adams	1893
6992	Bonniksen	1893
6993	Adams	1893
6994	J. Hewitt	1893
6995	A. P. W.	1893
6996 - 7003	J. Adams	1893
7004	Hawley	1893
7005 - 7009	Adams	1893
7010	Gardner	1893
7011	Hawley	1893
7012 - 7013	J. Adams	1894
7014	Hawley	1894
7015 - 7016	J. Adams	1894
7019	J. Adams	1894
7020 - 7021	Hawley	1894
7022 - 7023	J. Adams	1894
7024	Brown Bros.	1894
7025	J. Adams	1894
7026	Bonniksen	1894
7027 - 7028	J. Adams	1894
7029	J. Hewitt	1894
7030 - 7037	J. Adams	1895
7038	Robt. Gardner	1895
7039 - 7040	Hawley, Coventry	1895
7041	J. Hewitt	1895
7042 - 7044	J. Adams	1895
7045	Hawley, Coventry	1895
7046 - 7050	J. Adams, Coventry	1895
7051	Hawley	1895
7052 - 7055	J. Adams	1895
7056	J. Hewitt	1895
7057	Mermod Brothers Saints Croix	1895
7058 - 7059	J. Adams	1895

7060	Hewitt	1895
7061 - 7070	J. Adams	1895
7071 - 7072	Joseph Player	1895
7073 - 7076	J. Adams	1895
7078	J. Adams	1895
7079	Player	1895
7080 - 7085	J. Adams	1896
7086	J. Player	1896
7087 - 7098	J. Adams	1896
7099	J. Player	1896
7100 - 7101	Adams	1896
7102	Tripplin, c/o Rotherham	1896
7104 - 7106	J. Player & Son	1896
7107 - 7112	J. Adams	1896
7113	J. Player	1897
7114	J. Adams	1897
7115	Widmer	1897
7116	J. Adams	1897
7117 - 7120	J. Player	1897
7121 - 7125	J. Adams	1897
7126 - 7129	J. Player & Son	1897
7130	Woodhouse	1897
7131	J. Player & Son	1897
7132	J. Adams	1897
7133	J. Hewitt	1897
7134 - 7135	J. Player & Son	1897
7136	Adams	1897
7137	Weill & Harberg 18/11/85	1897
7138	Rotherham & Co.	1897
7139 - 7140	J. Player & Son	1898
7144	J. Adams	1898
7145 - 7146	J. White	1898
7147 - 7148	J. Player	1898
7149 - 7150	J. Adams	1898
7151	Player	1898
7152	Adams	1898
7153 - 7155	J. Player	1898
7156 - 7158	J. Adams	1898
7159 - 7160	Player	1898
7161 - 7168	J. Adams	1899
7169	J. Player	1899
7170 - 7171	J. Adams	1899
7173 - 7175	J. Adams	1899
7176	Player	1899
7177 - 7180	J. Adams	1899
7181	Player	1899
7182 - 7184	J. Adams	1899
7185 - 7186	J. Player	1899
7187	J. Adams	1899
7188	J. Player	1900
7189 - 7190	J. Adams	1900
7191 - 7192	Player	1900
7193 - 7203	J. Adams	1900
7204 - 7205	J. Player	1900
7206 - 7211	Adams	1900
7213	Player	1901
7214	J. Preston	1901
7215 - 7220	J. Adams	1901
7221	Golay	1901
7222	Hewitt	1901
7223 - 7224	J. Player & Son	1901
7225	Morton Smith	1901
7226 - 7238	J. Adams	1901
7239 - 7240	J. Player & Son	1902
7241 - 7242	Rotherham & Son	1902
7243	Adams	1902
7244	J. Player & Son	1902
7245	J. Adams	1902
7246	Rotherham	1902
7247 - 7248	Player	1902
7249	Bonniksen	1902
7250	Pratton	1902
7251	Rotherham	1903
7252 - 7254	Player	1903
7255 - 7256	Rotherham	1903
7257	Guignard	1903
7258	Hewitt	1903
7259 - 7263	J. Adams	1903
7264 - 7268	Rotherham	1903
7269	C. W. Guignard	1903
7270	Adams	1904
7271	Preston	1904
7272 - 7273	Bonniksen	1904
7274 - 7276	Rotherham	1904
7277 - 7279	Adams	1904
7280 - 7285	Rotherham	1904

7286 - 7287	Adams	1904
7288	Rotherham & Son	1904
7289 - 7290	Adams	1904
7291 - 7292	Rotherham	1904
7293 - 7294	Adams	1904
7295 - 7298	Rotherham	1904
7299	Hewitt	1904
7300	Rotherham	1904
7301	J. Adams	1905
7302	Player	1905
7303	J. Adams	1905
7304	Player	1905
7306 - 7311	J. Adams	1905
7312	Rotherham	1905
7313	Rotherham	1905
7314	J. Adams	1905
7315 - 7316	Rotherham	1905
7317	J. Adams	1905
7318 - 7320	Player	1905
7321	J. Adams	1906
7322	J. Player & Son	1906
7323	Rotherham	1906
7324 - 7325	J. Adams	1906
7326 - 7328	Rotherham	1906
7330	Haswell	1906
7331 - 7332	Rotherham	1907
7333	Haswell	1907
7334	Rotherham	1907
7335 - 7337	Haswell	1907
7338 - 7340	Rotherham	1907
7341	J. Adams	1908
7342 - 7343	Haswell	1908
7344	H. Golay	1910
7345 - 7349	Haswell	1910
7350	Audemars	1910
7351	Golay	1910
7352	Jones	1910
7353 - 7354	Rotherham	1911
7356	Rotherham	1912
7358 - 7362	Rotherham	1913
7363	Gent & Sons	1913
7364 - 7376	Rotherham	1913
7378	Gent	1913
7379 - 7383	Rotherham	1913
7384	Bingham	1913
7385	Rotherham	1913
7388 - 7454	Rotherham	1914-16
7456	Summers	1916
7457	Hitches	1916
7458 - 7465	Rotherham	1916
7466	Gardner	1917
7468 - 7472	Rotherham	1922-24
7473	Nicole Nielsen	1925

PARKINSON & FRODSHAM
MARINE CHRONOMETERS
MANUFACTURERS

4217	Mercer	2-day	July 17, 1890	for Negretti & Zambra
4218	Mercer	2-day	Oct. 1, 1890	for Negretti & Zambra
4219	Mercer	2-day	Feb. 4, 1889	
4220	Hewitt		Feb. 5, 1889	
4334	Johannsen		Sept. 19, 1890	Old seasoned chronometer
4337	Johannsen		Sept, 19, 1891	
4357	Hewitt	2-day	Nov. 19, 1890	

APPENDIX X

Charles Frodsham
Names of Manufacturers

05501 - 05504	Moore	1876	**05881**	Moore	1879
05505	Nicole	1876	**05882**	Audemars	1879
05506 - 05519	Moore	1877	**05884 - 05896**	Moore	1879
05520 - 05521	Garnish	1877	**05897**	Buckley	1878
05522	Cole	1876	**05898 - 05982**	Moore	1879
05525 - 05548	Moore	1877	**05983**	Buckley	1878
05549	Nicole	1877	**05984 - 06000**	Moore	1880
05550 - 05561	Moore	1877	**06001**	Nicole	1879
05562 - 05563	Nicole	1877	**06002 - 06008**	Preston	1880
05564 - 05586	Moore	1877	**06009 - 06016**	Audemars	1880
05630	Stock	1884	**06017 - 06018**	Preston	1880
05631	Moore	1889	**06019**	Heswell	1879
05690	Moore	1884	**06020**	Nicole & Co.	1880
05747 - 05752	Haswell	1879	**06021 - 06031**	Hewitt	1880
05757 - 05789	Moore	1879	**06023 - 06034**	Preston	1880
05790 - 05791	Buckley	1878	**06035 - 06036**	Hewitt	1880
05792	Moore	1878	**06037 - 06039**	Audemars	1880
05793 - 05798	Hewitt	1879	**06041**	Kullberg	1880
05799	Audemars	1878	**06042 - 06044**	Nicole & Co.	1880
05800 - 05822	Moore	1878	**06045 - 06046**	Audemars	1881
05823	Buckley	1878	**06047 - 06058**	Nicole & Co.	1881
05824 - 05829	Hewitt	1879	**06059**	Buckney	1880
05830 - 05835	Preston	1880	**06060**	Hewitt	1880
05836 - 05853	Hewitt	1880	**06064 - 06068**	Nicole	1881
05854	Buckley	1878	**06071**	Preston	1884
05855	Moore	1879	**06072 - 06074**	Nicole & Co.	1881
05856	Rome	1879	**06075**	Audemars	1881
05857 - 05858	Nicole	1879	**06076**	Nicole	1882
05859	Hewitt	1878	**06077**	Audemars	1880
05860	Preston	1879	**06078 - 06082**	Nicole	1881
05861 - 05862	Haswell	1883-98	**06083 - 06085**	Cooke	1881
05863	Hewitt	1884	**06036**	Droz	1882
05864 - 05866	Haswell	1884	**06087**	Garnish	1881
05867 - 05868	Hewitt	1879	**06088 - 06089**	Audemars	1880
05869 - 05872	Audemars	1879	**06090 - 06095**	Wellby	1880
05873 - 05874	Haswell	1879	**06096**	Audemars	1880
05875	Audemars	1884	**06097**	Nicole	1881
05876	Hewitt	1879	**06098 - 06099**	Audemars	1880
05877 - 05880	Haswell	1879	**06100 - 06199**	Moore	1881

06200 - 06201	Audemars	1881
06202 - 06203	Kullberg	1881
06204 - 06207	Audemars	1882
06208	Buckney	1883
06209 - 06214	Ashley	Not used
06215	Audemars	1881
06216	Nicole	1882
06217 - 06218	Smithson	1882
06219	Audemars	1881
06220	Nicole	1881
06221 - 06222	Moore & Co.	1881
06223 - 06224	Audemars	1882
06225	Nicole	1881
06226 - 06228	Audemars	1882
06229 - 06231	Nicole	1880
06232 - 06234	Audemars	1882
06235	Cooke	1882
06236	Hewitt	1881
06237 - 06238	Audemars	1882
06240	Preston	1881
06241 - 06246	Hewitt	1881
06247 - 06250	Nicole	1881
06251 - 06300	Moore & Co.	1881
06301	Hewitt	1884
06313 - 06317	Nicole	1881
06318	Houghton	1883
06319 - 06320	Moore & Co.	1881
06321	R B	1882
06323	Moore & Co.	1882
06330 - 06331	Moore & Co.	1881
06334 - 06335	Preston	1882
06336	Guillaume	1882
06337 - 06338	I.M.C.	1882
06339 - 06340	Nicole	1883
06341 - 06346	Trotman	1883
06347	Garnish	1881
06348	Buckney	1881
06349 - 06351	Nicole	1882
06352	Preston	1881
06353	Nicole	1881
06354 - 06368	Audemars	1884
06369	Preston	1881
06370	Nicole	1882
06371 - 06377	Preston	1885
06378 - 06379	Nicole	1883
06380 - 06383	Preston	1885
06384	Nicole	1882
06385 - 06386	Wellby	1882
06387	Hewitt	1882
06388	Preston	1883
06389	Audemars	1886
06390 - 06391	Preston	1882
06392	Smythson	1881
06393	Trotman	1884
06394	Hewitt	1882
06395 - 06399	Guillaume	1886
06400 - 06499	Moore	1882
06500	Nicole	1882
06501	Smythson	1882
06503 - 06504	Preston	1884
06505	Moore	1881
06506	Audemars	1884
06507 - 06510	Welby	1882
06511 - 06540	Moore	1882
06541 - 06548	Nicole	1882
06549	Phillips	1882
06550 - 06605	Moore	1882
06606 - 06622	Nicole	1882
06623 - 06624	Sythson	1882
06625 - 06626	Nicole	1882
06627	Preston	1882
06628	Nicole	1882
06629 - 06633	B	1882
06634 - 06635	Phillips	1882
06636	R B	1882
06638 - 06640	Nicole	1882
06641	B	1884
06642	Kullberg	1883
06643 - 06649	Nicole	1883
06650 - 06695	Moore	1884
06700 - 06701	Buckney	1882
06702 - 06703	Audemars	1885
06704 - 06713	B	1883
06714	Preston	1883
06715	Allamand	1883
06717	Smythson	1883
06718	Kullberg	1883
06719 - 06726	B	1883

06727 - 06728	Phillips	1883
06729 - 06734	B	1883
06735 - 06736	R B	1883
06737 - 06738	Golay	1883
06739 - 06744	B	1884
06746	R B	1883
06747 - 06750	Houghton	1884
06751 - 06756	B Preston	1883
06757	Golay	1883
06758 - 06759	B	1884
06760 - 06761	Buckney	1883
06762 - 06753	Golay	1883
06764 - 06769	Preston	1883
06770 - 06775	B	1883
06776	Golay	1883
06777 - 06780	Nicole	1885
06781 - 06786	B	1884
06787 - 06792	Preston	1884
06793 - 06796	Buckney	1884
06797 - 06798	R B	1883
06799 - 06801	Golay	1884
06802	Stock	1883
06803 - 06823	B Preston	1885
06824 - 06835	B	1883
06836 - 06849	Preston	1885
06850	Haswell	1883
06851 - 06853	—	1884
06854	Nicole	1883
06856	Phillips	1883
06857 - 06858	Moore	1883
06859 - 06871	Preston	1885
06872	Audemars	1884
06873 - 06875	B	1884
06889 - 06894	Preston	1886
06895 - 06909	R B	1884
06910 - 06934	Preston	1886
06935 - 06940	R B	1884
06941	Golay	1884
06942 - 06943	Preston	1884
06944	Golay	1884
06945 - 06962	B	1885
06963 - 06974	Preston	1885
06976 - 06987	B	1885
06988	Kullberg	1884
06975	Guillaume	1888
06989	Golay	1884
06990 - 07002	B	1886
07003 - 07006	Haswell	1884
07007 - 07018	Moore	1884
07019 - 07030	R B	1885
07031	Nicole	1884
07032	Kullberg	1885
07033 - 07071	Preston	1885
07072	Golay	1885
07073 - 07074	Nicole	1884
07075	Golay	1885
07076 - 07081	—	1885
07082	R B	1886
07083 - 07093	—	1885
07094	Golay	1885
07095	Nielson	1885
07096 - 07100	—	1885
07101	Nicole	1885
07102 - 07113	—	1887
07114 - 07125	Preston	1888
07126	Golay	1885
07127 - 07132	—	1885
07133 - 07144	Preston	1888
07145	Audemars	1885
07146 - 07151	—	1885
07152 - 07153	Nicole	1887
07154 - 07195	—	1886
07196	Grimshaw	1885
07197	Haswell	1886
07198	Preston	1888
07199	Nicole	1885
07200	Grimshaw	1885
07201 - 07212	—	1886
07213	Nielsen	1885
07214	Golay	1885
07215	Nielsen	1885
07216 - 07221		1887
07222	Kullberg	1886
07223 - 07224	Preston	1886
07225 - 07278	—	1886
07279 - 07282	Golay	1885
07283 - 07298		1887
07299	Gray	1886

07300 - 07303	—	1889
07304	Nicole	1886
07305 - 07309	—	1886
07310	Golay	1886
07211 - 07326	—	1891
07327 - 07330	Nicole	1886
07331 - 07334	Golay	1886
07335 - 07346	—	1887
07347 - 07352	Preston	1887
07353 - 07354	R B	1888
07355 - 07358	—	1887
07359	Nicole	1886
07360 - 07365	Preston	1889
07366 - 07370	Golay	1887
07371 - 07376	—	1887
07377 - 07379	Nicole	1886
07280 - 07386	Preston	1888
07387	Kullberg	1887
07388 - 07393		1887
07394	Moore	1886
07395 - 07397	Nicole	1887
07398 - 07399	Preston	1888
07400	Nicole	1886
07401	Triplin	1886
07402 - 07404	Haswell	1887
07405 - 07410	—	1888
07411 - 07419	Preston	1889
07420 - 07422	Nicole	1887
07423 - 07425	Golay	1887
07426 - 07428	Preston	1888
07429	Stock	1886
07430 - 07435	Preston	1888
07436 - 07437	Golay	1887
07438 - 07443	Preston	1888
07444	Haswell	1887
07445	Stock	1887
07446	Nicole	1887
07447 - 07448	Haswell	1887
07449	—	1887
07450	R B	1887
07451 - 07463	—	1887
07464 - 07466	Triplin	1887
07467	Golay	1887
07468 - 07469	Nicole	1888
07470	Golay	1887
07471	Preston	1887
07472 - 07473	Nicole	1887
07474 - 07475	Golay	1887
07476 - 07481	—	1888
07482	Nicole	1887
07483 - 07488	—	1888
07489 - 07490	Golay	1887
07491 - 07496	—	1888
07497	Tripplin	1887
07498 - 07499	Nicole	1888
07500 - 07502	Kullberg	1887
07503	Preston	1887
07504 - 07509	—	1888
07510	N A	1887
07512 - 07517	Trip	1887
07518 - 07519	Nicole	1887
07520 - 07525	Preston	1888
07526	Moore	1889
07527 - 07532	Golay	1887
07533	Nicole	1887
07534	Moore	1887
07535 - 07540	Preston	1888
07541 - 07556	Haswell	1887
07557 - 07562	Preston	1889
07563 - 07565	Nicole	1888
07566 - 07571	Nielson	1888
07572	Preston	1888
07573 - 07585	Haswell	1889
07586 - 07587	—	1889
07588 - 07593	Preston	1892
07594	Golay	1891
07595	Preston	1888
07596 - 07597	Nicole	1888
07598	Golay	1888
07599 - 07604	Nicole	1891
07605 - 07607	Golay	1888
07608 - 07626	Preston	1892
07627 - 07635	Nicole	1890
07636 - 07644	Nielson	1891
07645 - 07656	Roth	1889
07657	Golay	1888
07658 - 07661	Haswell	1888
07662	Moore	1888

07663 - 07678	Preston	1889
07679	Haswell	1891
07680	Moore	1888
07681	Preston	1888
07682 - 07683	Golay	1888
07684 - 07689	Preston	1889
07690	Golay	1888
07691 - 07692	Preston	1889
07693	Golay	1889
07694 - 07703	Haswell	1890
07706	Moore	1891
07707 - 07717	Preston	1891
07718	Moyon & Co.	1888
07719 - 07726	Preston	1890
07727 - 07728	Nielson	1888
07729 - 07732	Preston	1890
07733	Nielson	1889
07736 - 07748	Preston	1889
07749 - 07751	Golay	1888
07752 - 07757	Preston	1891
07758	Rotherham	1889
07759	Trip	1889
07760 - 07774	Preston	1893
07775 - 07776	Roth	1889
07777	Golay	1889
07778 - 07779	Nielson	1889
07780 - 07791	Trip	1889
07792	Nielson	1889
07793 - 07798	Preston	1892
07799	N & N	1890
07800	Roth	1890
07801 - 07802	N & N	1890
07803 - 07805	Haswell	1892
07806	Golay	1890
07807 - 07812	Preston	1892
07813	Nielson	1891
07814	Baxter	1889
07815 - 07816	Nielson	1892
07817 - 07818	Golay	1890
07819	Haswell	1889
07820	Nielson	1890
07821 - 07842	Preston	1890
07843	Golay	1890
07844 - 07845	Nielson	1890
07846 - 07857	Preston	1891
07858 - 07859	Roth	1889
07860	Golay	1890
07861 - 07872	Preston	1893
07873	Buckney	1890
07874	Stock	1890
07875 - 07893	Preston	1892
07894	Roth	1890
07895 - 07896	Preston	1890
07899 - 07910	Preston	1890
07911	Moore	1890
07912	Stock	1890
07913 - 07918	Preston	1893
07919 - 07920	Moore	1891
07921 - 07922	Nielson	1890
07923 - 07928	Preston	1891
07929 - 07932	Golay	1890
07933 - 07935	Preston	1895
07936	Roth	1890
07937 - 07949	Preston	1891
07950 - 07952	Golay	1890
07953 - 07955	Preston	1890
07956	Trip	1890
07957 - 07959	Preston	1891
07960	Trip	1890
07961 - 07978	Preston	1892
07979	R B	1890
07980 - 07985	Preston	1891
07986 - 07993	Golay	1892
07994	Preston	1900
07995	Moore	1890
07996 - 08002	Golay	1892
08003 - 08019	Trip	1891
08020 - 08027	Preston	1891
08028 - 08030	Golay	1892
08031 - 08043	Preston	1893
08044 - 08045	Moore	1891
08046 - 08057	Trip	1892
08059 - 08064	Preston	1896
08065	Trip	1891
08066 - 08071	Preston	1892
08072 - 08073	Stock	1893
08074 - 08075	Preston	1892
08076	Moore	1892

08077	Trip	1891
08078	Moore	1891
08079	Trip	1891
08080	Nielson	1893
08081 - 08082	Golay	1891
08083	Baxter	1891
08084 - 08087	Nielson	1891
08088	Baxter	1891
08089 - 08092	Trip	1891
08093	Moore	1891
08094 - 08098	Trip	1891
08097 - 08098	Haswell	1891
08099 - 08110	L. W. Co.	1892
08111 - 08112	Moore	1893
08113	Nielson	1892
08114 - 08117	Trip	1891
08118 - 08124	Preston	1892
08125	Trip	1891
08126 - 08127	Preston	1892
08128	Neilson	1891
08129 -08130	Trip	1892
08131 - 08135	Neilson	1892
08136 - 08137	Preston	1892
08138	Trip	1892
08139 - 08142	Preston	1893
08143	Trip	1892
08144 - 08149	L. W. Co.	1893
08150 - 08151	Preston	1894
08152 - 08157	Aud	1892
08158 - 08167	Preston	1892
08168	Trip	1892
08169	Lin	1892
08170 - 08174	Neilson	1894
08175 - 08180	Trip	1892
08181 - 18182	Preston	1900
08183 - 08186	Trip	1893
08187	Preston	1892
08188 - 08193	Trip	1892
08194 - 08195	Neilson	1892
08196	Golay	1892
08197	Moore	1892
08198 - 08203	Neilson	1892
08204 - 08206	Trip	1892
08207 - 08224	Preston	1894
08225	Trip	1892
08226	Usher	1892
08227 - 08228	Neilson	1894
08229 - 08232	Aud	1892
08233	Neilson	1892
08234	Preston	1893
08235 - 08238	Trip	1892
08239 - 08245	Preston	1893
08246 - 08250	Moore	1893
08251 - 08252	Golay	1893
08253 - 08258	Preston	1902
08259 - 08274	Trip	1893
08275	Neilson	1893
08276 - 08277	Preston	1893
08278 - 08280	Neilson	1893
08281 - 08284	Trip	
08285 - 08290	Preston	1898
08291 - 08293	Neilson	1893
08294 - 08299	Preston	
08300	Furneaux	1901
08301	Preston	1902
08302	Golay	1894
08303	Preston	1902
08304	Golay	1895
08305 - 08306	Preston	1902
08307 - 08308	Moore	1894
08309 - 08317	Preston	1893
08318	Aud	1893
08319	Golay	1895
08320 - 08322	Aud	1893
08323	Preston	1893
08324	Neilson	1893
08325 - 08330	T. P.	1894
08331	Baume	1893
08332	Trip	1893
08333 - 08338	T. P.	1894
08339	Haswell	1894
08340 - 08348	Trip	1894
08349 - 08350	Baume	1894
08351	Trip	1894
08352 - 08355	Baume	1894
08356 - 08367	Preston	1898
08368 - 08379	T. P.	1895
08380 - 08381	Neilson	1895

08382 - 08387	T.P.	1895
08388 - 08390	Preston	1898
08391	Trip	1894
08392 - 08393	Neilson	1896
08394 - 08395	Trip	1894
08396 - 08397	Preston	1895
08398	Trip	1894
08399 - 08401	Neilson	1895
08403 - 08414	Tripplin	1895
08415 - 08417	Neilson	1895
08418 - 08428	Trip	1895
08429 - 08434	Preston	1897
08435 - 08437	Neilson	1895
08438 - 08440	Preston	1896
08441	Trip	1895
08442	Nielsen	1896
08443 - 08465	N. N. & Co.	1886
08467 - 08470	Baume	1896
08471 - 08478	Tripplin	1896
08479 - 08482	Baume	1896
08483	N. N. & Co.	1895
08484 - 08487	Golay	1895
08488 - 08499	Preston	1898
08500	Bonniksen	1896
08501	N. & N.	1896
08502	R B Stock	1897
08503 - 08504	N. N. & Co.	1895
08505 - 08510	Tripplin	1896
08511	N. N. & Co.	1896
08512	Tripplin	1896
08513 - 08515	Preston	1904
08516 - 08519	N. N. & Co.	1896
08520 - 08521	Tripplin	1896
08522 - 08532	N. N. & Co.	1896
08533 - 08544	Baume	1896
08545 - 08551	Tripplin	1897
08552	Furneaux	1896
08553	N. N. & Co.	1897
08554 - 08561	Tripplin	1897
08562 - 08566	Preston	1898
08567 - 08574	N. N. & Co.	1897
08575 - 08584	Tripplin	1897
08585	Golay	1897
08586 - 08603	N. N. & Co.	1897
08604 - 08609	Tripplin	1897
08610 - 08613	N. N. & Co.	1897
08614 - 08615	Tripplin	1897
08616 - 08617	N. N. & Co.	1898
08618	Tripplin	1897
08619	N. N. & Co.	1897
08620	Tripplin	1898
08621	Nielsen	1897
08622 - 08625	Tripplin	1897
08626 - 08631	N. N. & Co.	1898
08632 - 08646	Preston	1901
08647 - 08659	N. N. & Co.	1898
08660	Preston	1906
08663 - 08665	N. N. & Co.	1898
08666 - 08671	Tripplin	1898
08672	N. N. & Co.	1898
08673 - 08687	J. Preston	1898
08688	N. N. & Co.	1899
08689	Tripplin	1898
08690 - 08707	N. N. & Co.	1899
08708	Golay	1899
08709 - 08714	Preston	1901
08715 - 08716	N. N. & Co.	1899
08717	Tripplin	1899
08718 - 08728	N. N. & Co.	1899
08729	Golay	1899
08730 - 08734	N. N. & Co.	1900
08735 - 08743	Tripplin	1900
08744	Golay	1899
08745	N. N. & Co.	1899
08746 - 08751	J. Preston	1901
08752	Golay	1899
08753 - 08763	N. N. & Co.	1900
08764 - 08766	Preston	1901
08767 - 08769	Golay	1900
08770 - 08775	Preston	1901
08776 - 08795	N. N. & Co.	1900
08796 - 08801	Preston	1901
08802 - 08812	N. N. & Co.	1901
08813	Golay	1900
08814 - 08820	N. N. & Co.	1901
08821 - 08826	Tripplin	1901
08827	N. N. & Co.	1900
08828 - 08830	Preston	1903
08831 - 08836	Tripplin	1901
08837 - 08839	N. W. & Co.	1901

08840 - 08841	Ditisheim	1907
08842	Tripplin	1900
08843	Golay	1901
08844	Tripplin	1901
08845 - 08853	N. N. & Co.	1901
08854	Tripplin	1900
08855 - 08856	N. N. & Co.	1902
08858	Golay	1901
08859 - 08866	Preston	1903
08868 - 08873	N. N. & Co.	1902
08874	Tripplin	1901
08875 - 08878	N. N. & Co.	1902
08879	J. Player	1901
08880 - 08891	N. N. & Co.	1902
08892	Player	1902
08893 - 08896	N. N. & Co.	1902
08897	H. J. F.	1902
08898	N. N. & Co.	1902
08899	H. J. F.	1904
08900	N. N. & Co.	1902
08904 - 08905	Preston	1903
08906 - 08914	N. N. & Co.	1902
08915	Player	1902
08916 - 08919	N. N. & Co.	1902
08920 - 08921	H. J. F.	1903
08922 - 08947	N. N. & Co.	1902
08948 - 08949	Bonniksen	1903
08950 - 08958	N. N. & Co.	1902
08959	Milne	1902
08960 - 08967	N. N. & Co.	1902
08968 - 08973	Preston	1903
08974	N. N. & Co.	1902
08975	R. B. Stock	1902
08976 - 08981	N. N. & Co.	1903
08982	H. J. F.	1904
08983 - 08993	N. N. & Co.	1903
08994	Hewitt	1903
08995 - 09006	N. N. & Co.	1903
09007	Tripplin	1903
09008 - 09040	N. N. & Co.	1904
09041 - 09042	Tripplin	1903
09043 - 09049	N. N. & Co.	1904
09050	Bonniksen	1903
09051 - 09052	N. N. & Co.	1904
09054	Player	1903
09055	Hewitt	1903
09056 - 09058	Preston	1907
09059	Player	1904
09060 - 09076	N. N. & Co.	1904
09077	Preston	1904
09078 - 09081	N. N. & Co.	1905
09082/51606	Carley & Clemence	1906
09083 - 09096	N. N. & Co.	1905
09097	Bonniksen	1905
09098 - 09112	N. N. & Co.	1905
09113	Stock late Hall	1905
09114 - 09116	N. N. & Co.	1905
09117	Audemars	1905
09118	Tripplin	1905
09119 - 09130	N. N. & Co.	1906
09131	Tripplin	1906
09132 - 09135	N. N. & Co.	1906
09136	Tripplin	1906
09137 - 09140	N. N. & Co.	1906
09141	J. Hewitt	1906
09142 - 09182	N. N. & Co.	1907
09183	Rotherham	1906
09184 - 09186	N. N. & Co.	1907
09187 - 09189	Preston	1907
09190	N. N. & Co.	1907
09191	B. Bonniksen	1907
09192 - 09253	N. N. & Co.	1908
09254	J. Hewitt	1909
09255	Rotherham	1908
09256 - 09263	N. N. & Co.	1909
09265	Jas. Hewitt	1909
09266 - 09267	N. N. & Co.	1909
09268	Rotherham & Son	1909
09269 - 09288	N. N. & Co.	1909
09289	Audemars	1909
09290	N. N. & Co.	1909
09291	Newsome & Co.	1909
09292 - 09293	Jno. Hewitt	1910
09294 - 09296	N. N. & Co.	1910
09297	Newsome	1909
09298 - 09315	N. N. & Co.	1910
4/1891	Bonniksen	1896

(Nielson was sometimes spelt " Neilson " in the books.)

APPENDIX XI

Charles Frodsham Movements made by Victor Kullberg

In the following, C = Chronometer.
Cyl = Cylinder.
L = Lever.
u/d = up & down.

A.D.	C.F. Number	Esct	Size	Plate	Keyless		V.K. Number	
1862	**02033**	L			,,			
	02034	L			,,			
1863	**02391**				,,			
1864	**02473**		16					
	02903	L	16		,,			
	02906	L						
1865	**02907**		16		,,	u/d		
	02908	L	6		,,	u/d		
	02909				,,			
	02910				,,			
	02911				,,	u/d		
	03078		6		,,			
	03228		12		,,			
	03229		16		,,			
	03231		14		,,			
	03259	L						
1869	**03261**	C	16		,,	u/d		Centre Secs
	03262	C	16	½	,,	u/d	K 1460	
	03263	C	16		,,	u/d		
1870	**03669**							
1869	**03835**				,,	**u/d**		
1870	**04126**	L	6	½	,,	u/d	K 1776	
	04127	L	6		,,		K 1777	
	04128	L	6	½	,,		K 1778	
	04129	L	6	½	,,		K 1779	
	04195	L	18	½		u/d	K 1597	
1871	**04196**	L	18	½	,,	u/d	K 1791	
	04348	L	18	½	,,	u/d	K 2004	
	04349	L	18	½	,,	u/d	K 2005	
	04350	L	18	½	,,	u/d	K 2006	
	04351	L	18	½	,,	**u/d**	K 2021	
1880	**06041**		14		,,	u/d	K 3881	
1881	**06201**	C						
1881	**06202**	C	16			u/d	K 3933	

	06203	C	16		,,		K 3932	
1882	**06642**	Cyl	18	½	,,		K 4179	
1883	**06642**				,,		K 4371	New m'ment
1884	**06988**	C	16		,,	u/d	K 4520	
	07032	C	16	½	,,		K 4699	
1885	**07222**	C	16	½	,,		K 4700	
1886	**07387**	C	16	½	,,		K 4597	
1887	**07500**	C	16		,,		K 4908	
	07501	C	16	½	,,		K 4701	
	07502	C	14	½	,,		K 4622	
1884	**0019**	C	8-day		,,		K 4106	
Parkinson & Frodsham								
1869	**5458**	L	14	½			K 1514	

Mr. R. F. Carrington was kind enough to give me the above records.

APPENDIX XII

Charles Frodsham. Chronometer Clocks.

Made by the firm of **Thomas Mercer.**

Nos.	**504, 505, 511, 512, 516, 520**	8-day	£24	1922
	522, 523, 525, 526, 531, 533	8	24	1923
	2252 - 2254, 2360 - 2364, 2367, 2369	8	24	1923
	2371, 2372, 2387, 2388, 2399, 2413	8	24	1924
	2426 - 2428, 2432, 2433, 2435, 2436, 609	8	24	1925
	2457 - 2459	8	24	1927
	10066, 10067/12397	2	28	1923
	12231	2	35	1924
	10068	2	38·10s.	1927
	10069	2	27·10s.	1928

APPENDIX XIII

GREENWICH TRIALS

Rates of CHRONOMETERS on Trial for Purchase by the Board of the Admiralty at the Royal Observatory Greenwich

		Charles Frodsham			Trial Number (a + 2b)	Day
1840	**1715**				21.8	
	1806				37.6	
	1686				38.2	
1841/42	**1957**				39.9	2
1841/42	**1967**				41.5	2
	1960				48.4	2
	1917				55.9	2
1842/43	**1957**				30.8	2
	1869				45.1	2
1845	**1482**				46.1	2
	1481				73.7	2
	1516*				114.4	2
	1540*				119.8	2
	1516	(More severe trial)			22.8	2
	1540	,,	,,	,,	35.2	2
1846	**1485***				77.0	2
	1485	,,	,,	,,	56.9	2
1847	**2074***				29.2	2
	2066*				39.5	2
	2074	,,	,,	,,	15.4	2
	2066	,,	,,	,,	26.8	2
1848	**2081***				65.3	2
	1516				65.3	2
	2081				77.7	2
1849	**1962**				72.1	2
1850	**2081**	Double balance. (1, ordinary comp. balance 2, Arnold's bar.)			43·8	2
1851	**2352**	,,	,,	,,	59.3	2
1852	**2273**	,,	,,	,,	61.5	2
1853	**2484**	Ordinary construction			68.1	2
1862	**3155**	No information		84 Strand	33.1	2
	3188	,,	,,	,,	45.3	2

* These chronometers were exposed to the air on the North side of the building during certain weeks.

1863	**3155**	Ordinary comp. + experimental auxiliary for high temps.	32.6	2
1865	**3316**	Usual balance + supplementary compensation	44·0	2
1866	**3342**	„ „ „ „	28.9	2
	3316	„ „ „ „	36.4	2
1867	**3345**	„ „ with continuous auxiliary	48.8	2
	3392	„ „ + supplementary compensation	52.3	2
1868	**3392**	„ „ „ „	32.2	2
	3345	Usual balance with continuous auxiliary	43.9	2
1869	**3392**	„ „ + equation compensation check-piece fitted on the arm of the balance	24.8	2
	3372	New continuous auxiliary to balance. Has also galvanic apparatus for recording its time on chronographs	43.1	2
1870	**3345**	No information	27.2	2
	3364	„ „	32.2	2
1871	**3423**	Charles Frodsham's new reverse balance	15.2	2
	3461	Continuous auxiliary to balance	23.1	2
1874	**3519**	Three compensation bar balance	30.1	2
	3554	Balance with continuous auxiliary	30.3	2
1882	**3593**	(& Co.) Three compensation bar balance	15.9	8
	3576	Three compensation bar balance with Galvanic apparatus. 377 Strand.	57.1	2
1883	**3597**	C. Frodsham's three bar compensation balance	40.6	8
	3598	„ „ „ „ „ 84 Strand	66.9	8
1884	**0003**	„ „ „ „ „	17.5	2
1885	**3597**	„ „ „ „	23.8	8
	3532	Trochilic escapement. Ordinary balance with auxiliary	31.9	2
1887	**0011**	(& Co.) Ordinary balance	15.2	2
	0012	„ „	37.4	2
	3600	„ „	70.3	8
1889/90	**0018**	Three bar compensation balance	32.8	2
	0017	„ „ „ „	55.2	2
1897/98	**0037**	(& Co.) Auxiliary Compensation. Bright Steel Spring	40.4	2
1899-1900	**0029**	„ C.F.s 3 bar Compensation balance „ „	40·8	2
	0042	„ Ordinary B. Auxiliary for extremes „ „	40.8	2
1902/03	**10047**	(& Co.) Auxiliary compensation to B. Bright „ „	27.9	2
1903/04	**10049**	„ Nickel steel balance; bright steel spring	35.5	2
	0029	„ C.F.s 3 bar balance „ „ „	39.5	2
1904/05	**10051**	„ Auxiliary comp. balance „ „ „	37.2	2

909/10	**10052**	Auxiliary balance acting to cold. Palladium spring 115 New Bond Street	37.5	2

	Parkinson & Frodsham		Trial Number (a + 2b)	Day
1840	**2277**		30.4	
	2264		31.1	
	2291		36.2	
	2310 P	(**P** = pocket)	44·1	
	2674 P		62.9	
1841	**2523**		35.3	
	571		40.1	
	2324		44.2	
1841/42	**2496**		46.4	2
	2451		47.6	2
	2452		48.2	2
	2467		57.5	2
	2209		58.7	2
	2434		77.4	2
	541 P		77.4	
	2674 P		94.0	
1842/43	**2496**		31.6	2
	2464		61.0	2
	2467*		64.5	2
	2451*		94.7	2
	2451	(more severe trials)	41.3	2
	2467	„ „ „	43.4	2
1844	**2791**		30.2	2
	2614		32.4	2
	2792		34.5	2
	2630		68.1	2
1845	**2955 P**		24.2	
	1886 P		34.3	
	2630		49.4	2
	2622		52.2	2
	2791		60.9	2
	2792		108.7	2
1846	**2595**		31.4	2
	2958		48.2	2
	2633		61.6	2
1847	**2451**		40.8	2

	2622		77·2	2
1848	**2661**		42.0	2
	2593		83.0	2
1849	**2593**		81.5	2
1850	**2685**	Ordinary construction	62.1	2
1861	**3705**	Auxiliary to ordinary balance. 4 Change Alley, Cornhill	38.0	2
	3474	,, ,, ,,	80.5	2
1862	**3474**	,, ,, ,,	35.0	2
	3701	,, ,, ,,	36.8	2
1863	**3689**	,, ,, ,,	52.5	2
	3031	,, ,, ,,	79.1	2
1864	**3474**	,, ,, ,,	55.1	2
	3701	,, ,, ,,	59.7	2
1872	**4033**	Auxiliary permanently in action	69.7	2
1875	**4113**	2 Auxiliaries to ordinary balance, one acting in cold, the other in heat	33.6	2
1881	**4158**	Auxiliary acting at low temperatures	50.2	2
1882	**4167**	,, ,, ,, ,,	27.7	2
	4158	,, ,, ,, ,,	35.1	2
1899/1900	**4284**	Auxiliary Compensation acting in heat. Palladium spring	26.8	2
	4283	,, ,, ,, ,, ,, ,,	30.4	2
	H. Frodsham			
1846	**2703**		110.8	2
	Frodsham & Keen			
1893/94	**3835**	Poole's auxiliary	66.5	2
	3836	,, ,,	269.0	2
1895	**3868**	Improved ordinary balance. 31 South Castle Street	49.2	2
	G. E. Frodsham			
1869	**6524**	Auxiliary for extreme heat. 31 Gracechurch Street	41.0	2
	Arnold & C. Frodsham			
1846	**1509***		55.6	2
	Frodsham & Baker			
1855	**6068**	Auxiliary compensation to balance	38.5	2

1856	**6103**	„ „ „	60.6	2
	6102	„ „ „ A dead seconds beat	130.4	2
1857	**6109**	„ „ „	83.5	2
1858	**7163**	„ „ „	30.4	2
1859	**6188**	„ „ „ 31 Gracechurch Street	31.2	2
	6149	„ „ „	38.9	2
1860	**6242**	„ „ „	35.2	2
	6177	„ „ „	51.3	2
1861	**6177**	„ „ „	68.1	2
	6242	„ „ „	101.4	2
1862	**6220**	Ordinary balance	83.5	2
	6223	Auxiliary to balance	126.1	2

C. M. Frodsham, junior

1861	**3/3250**	Ordinary compensation with definite proportions	71·9	2
1862	**3/3308**	No information. 84 Strand	31.8	2
	3/3250	„ „	37·4	2
1863	**4/3348**	New construction of balance	53.1	2
	3/3308	„ „	44.3	2
1864	**4/3348**	New auxiliary for all temperatures	23.2	2
1865	**3/3308**	Usual balance with continuous auxiliary	23.9	2
	3362	„ „ „ auxiliary compensation	89.5	2
1868	**3362**	„ „ „ „ „	81.8	2

Rates of DECK WATCHES on Trial

$$a + 2b + \tfrac{1}{2}\left(c + \frac{d+e}{3}\right)$$

Charles Frodsham

1889/90	**07462**	37.5
	07586	41.3
	07587	72.0
1890/91	**07953**	93.0
	07463	98.7
1891/92	**07959**	62.2
	08075	75.0
	07957	101.6
1892/93	**08073**	93.0
	08093	128.4
	07958	226.3
1893/94	**08139**	106.8
	08140	290.8

1896/97	**08312**	63.2
1897/98	**08310**	93.2
1899/1900	**08310**	72.0
	08311	95.7
1902/03	**08959**	82.3
	08902	88.8
1904/05	**08959**	68.4
1905	**08959**	88.2
	Parkinson & Frodsham	
1904/05	**7272**	68.7
1906	**7272**	75 6
	7273	79.9

APPENDIX XIV

KEW CERTIFICATES

The records of the Kew Certificates are now to be found at the National Physical Laboratory at Teddington, Middlesex. At present they are kept in the basement of Bushey House and it is due to the kindness and co-operation of Mr. D. S. Sutcliffe and Mr. B. Swabey that I have been able to examine these records. I am most grateful for their help.

There are seven main volumes of watch records and three of marine chronometer records. Each watch and chronometer was given a Kew reference number and each watch was described briefly in these volumes. To find the abstracts of the ratings one has to make a note of the Kew reference number and look elsewhere for these ratings. In the case of watches the abstracts of the ratings are to be found, either at the end of Volume 1, or in separate books for each of the other volumes. These abstracts of the ratings are given with reference to the Kew reference number. Here one finds the various rates and at the end of each line the marks awarded can be seen.

The first of these ratings commenced on the 13th May, 1884, and, after two months a slight change in the method of rating was decided upon. This is pointed out at the foot of page 1, of the abstracts, as follows :

> Watches previous to July 17th were worked out, taking the mean of the three vertical positions and the mean of the two horizontal positions, with respect of change of daily rate from vertical to horizontal positions (rule 2 Class A), **not** pendant up and dial up as was afterwards decided upon.

For details of the actual certificates awarded please consult *Edward John Dent,* pages 729 - 732.

The Kew Certificate Class A was discontinued in 1951. However, after 1951, the rating of watches and chronometers was still undertaken at Teddington but no 'A' certificates were awarded. These ratings were discontinued at Teddington in June 1978, when the firm of Thomas Mercer at St. Albans agreed to take over the work.

The method of working out the marks to be awarded is at first sight somewhat complicated; the following is an attempt to make the scheme understandable.

Class A Trial. Watches

This occupied 45 days which were divided into 8 periods of 5 days each, leaving 5 intermediate days during which the watch was not rated.

1st period.	Pendant up.	Room temperature.	About 65° Fahr.
2nd „	Pendant to right.	„	„
3rd „	Pendant to left.	„	„
4th „	Dial up.	At about 40° Fahr.	Refrigerator
5th „	Dial up.	At room temperature.	About 65° Fahr.
6th „	Dial up.	At about 90° Fahr.	Oven.
7th „	Dial down.	Room temperature.	
8th „	Pendant up.	Room temperature.	

To obtain a certificate.

The mean daily rate must not exceed 10 secs.

The mean variation of daily rate during each period must not exceed 2 secs.

The difference of mean daily rate between pendant up and dial up must not exceed 5 secs. and between pendant up and any other position, 10 secs.

Variation of temperature must affect the daily rate by less than one-third of a second per degree Fahrenheit.

Marks.

A certificates were awarded marks to indicate the degree of excellence. 100 marks being full marks. 40 for no variation of rate.

40 for no change of rate with change of position.

20 for no temperature error.

This method of marking had already been used by Professor Waldo at Yale Observatory. The formulae for obtaining the marks are as follows :

Daily Rate Variation.

Since the maximum limit of daily variation is 2.0 sec., and the maximum marks are 40, each mark will have the value of 0.05 sec., and so,

$$\frac{2.0 \text{ sec.} - d}{0.05} = \text{marks for variation, or } 40 - \left(\frac{d}{2} \times 40\right)$$

Position (p).

Since the maximum limit of variation for position is 10 sec., and the maximum marks are 40, each mark will have the value of 0.25 sec., and so,

$$\frac{10.0 \text{ sec.} - p}{0.25} = \text{marks for position, or } 40 - 4p$$

Temperature (t).

Since the maximum limit of variation for 1° Fahr. is 0.3 sec., and the maximum marks are 20, each mark will have the value of 0.015 sec., and so,

$$\frac{0.30 \text{ sec.} - t}{0.015} = \text{marks for temperature, or } 20 - \left(\frac{t}{0.3} \times 20\right)$$

Estimation of Rates of Variation.

At first sight this seems to be a rather complex proceedure, until one understands the basic principles which are as follows :

The **actual** daily rate is noted for each day of each five-day period.

Each five-day period has its five rates added together and divided by 5 in order to obtain the **mean daily rate** for each period, i.e. 8 mean daily rates.

The difference or variation of each **actual** rate from the **mean rate** for its period is now tabulated. The 5 **variations** are now added together and divided by 5 to produce the **average variation.**

Daily Rate Variation.

To obtain this the average variations for all eight periods are added together and divided by 8 to produce the **grand mean variation of daily rate** = d.

Positional Variation.

This is obtained by adding together the **mean rates** for periods 1, 2, 3, 5, 7 and 8, and dividing by 6 to produce a **grand mean.**

The difference or variation between each of the 6 **mean rates** from the **grand mean** is now tabulated and these 6 variations are added together and divided by 6 to produce the **mean positional variation** of rate, = p.

Variations due to a change of Temperature.

This is obtained by adding together the **mean rates** for periods 4, 5 and 6, and dividing by 3 to produce a **grand mean.**

The three temperatures are added together and divided by 3 to give the mean temperature.

The difference between each of the three mean rates from the grand mean is now tabulated and added together to produce the sum of departures of rate.

The differences between the three temperatures and the mean temperature are tabulated and added together to produce the sum of departures of temperature.

The sum of the departures of rate divided by the sum of the departures of temperature give the **mean change of rate per 1°** Fahr. change of temperature, = t.

References.

Horological Journal: August 1885, p. 168-169. January 1886, p. 69-70. August 1886, p. 187. December 1886, p. 63-64. January 1887, p. 74-75. April 1928, p. 145-149. May 1928, p. 170-172. June 1928, p. 190-191. July 1928, p. 210-211. October 1934, p. 48-51. December 1934, p. 111-117. February 1935, p. 182-186.

De Carle. *British Time*, p. 186-195.

CHARLES FRODSHAM

KEW CERTIFICATES for Watches

Abreviations: G = gold; S = silver; Nkl = Nickel; kw = key wind; kys = keyless; cg = chronograph; pl = plate; sr = single roller; dr = double roller; eg = extra good; gb = going barrel

Kew No.	Watch No.	Class	Marks	Date
13149	**2183**	S. Kw. full pl. fusee Chronometer Arnold Restored by Frodsham 1858 A		
13192	**2183**	Smith's A.eg	77.6	Dec. 1907
10597	**3003**	G. Kys. ¾ 1. dr. gb. ¼ Rep. Min. Chronog. B	80.6	March 1908 July 1901

28319	**5470**	MP Chronog. $^1/_5$ sec. 30 mins. Police test Failed			April	1947
1046	**8214**	G. Kys. $\frac{3}{4}$ pl. sr. fusee (28 year old Arnold)	None		April	1887
1088	**8214**	G. Kys. $\frac{3}{4}$ pl. sr. fusee (28 year old Arnold)	None		June	1887
1290	**8214**	G. Kys $\frac{3}{4}$ pl. sr. fusee (28 year old Arnold)	B		Sept.	1887
8806	**01398**	G. Kw. $\frac{3}{4}$ pl. sr. fusee	None		Aug.	1897
8933	**01398**	,,	A	68.0	Nov.	1897
109	**01521**	G. Kw. $\frac{3}{4}$ pl. fusee Chronometer	A		March	1885
6470	**01521**	G. Kw. $\frac{1}{2}$ pl. fusee Chronometer	A	74.0	March	1894
3	**03279**	G. lever	B		May	1884
3572	**03452**	G. Kys $\frac{3}{4}$ pl. sr. gb.	None		Sept.	1891
9859	**03452**	,,	None		Sept.	1899
1982	**03474**	G. Kys $\frac{3}{4}$ pl. sr. gb.	A	68.0	Sept.	1888
334	**03774**	G. Kw. $\frac{3}{4}$ pl. dr. fusee	B		Dec.	1885
515	**03774**	G. Kw. $\frac{3}{4}$ pl. dr. fusee	A	70.7	Feb.	1886
3688	**04386**	G. Kys $\frac{1}{2}$ pl. dr. fusee	A	70.9	Nov.	1891
991	**05424**	G. Kys $\frac{3}{4}$ pl. dr. gb.	None		Nov.	1886
1067	**05424**	,,	A	72.0	April	1887
855	**05824**	S. Kys $\frac{1}{2}$ pl. dr. gb.	A	74.9	Nov.	1886
498	**06970**	G. Kys $\frac{3}{4}$ pl. dr. gb. S & platina balance Palladium Sp.	A	69.5	Feb.	1886
310	**07140**	G. Kys $\frac{3}{4}$ pl. sr. gb.	A	56.7	Sept.	1885
1035	**07369**	G. Kys $\frac{3}{4}$ pl. sr. gb. Min. & split chronog.	A	73·7	May	1887
11527	**07369**	,, Papers endorsed			June	1903
11096	**07432**	G. Kys. $\frac{3}{4}$ pl. dr. gb.	None		June	1902
11171	**07432**	,,	A	58.2	Nov.	1902
12855	**07432**	,,	None		Oct.	1906
12963	**07432**	,,	A	79.4	April	1907
15286	**08081**	G. Kys dr. gb. Min. rep. Min. & sec. chronog. Entered by Rowland Burrett	A	74.8	Dec.	1912
12632	**08356**	G. Kys $\frac{3}{4}$ pl. dr. gb. Nickel-steel balance	A.eg	87.9	Dec.	1905
7573	**08454**	G. Kys. $\frac{3}{4}$ pl. dr. gb. Min. & split chronog.	A	71.9	Oct.	1895
13521	**08570**	G. Kys $\frac{3}{4}$ pl. dr. gb. Min. & sec. chronog.	A.eg	86.6	April	1908
9795	**08647**	G. Kys. $\frac{1}{2}$ pl. dr. fusee lever Tourbillon	A	86.7	July	1899

9892	**08647**	,,	A	84.5	Oct.	1899
10008	**08647**	,,	A.eg	84.8	Jan.	1900
10080	**08753**	G. Kys ½ pl. Tourbillon lever dr. fusee	A.eg	86.1	March	1900
10532	**08767**	G. Kys. ¾ pl. min. & split chronog. Karrusel sr. gb.	A	73.5	April	1901
11974	**08845**	G. Kys ¾ pl. min. & split cg. min. rep. dr. gb. Lever Tourbillon	A.eg	81·7	June	1904
10847	**08867**	G. Kys ¾ pl. min. & split cg. min. rep. dr. gb. Tourbillon	A	78.4	March	1902
11126	**08868**	G. Kys ¾ pl. Tourbillon dr. fusee	A	74.5	July	1902
11262	**08868**	,, gb.	A.eg	85.8	Dec.	1902
13344	**08868**	,, fusee	A.eg	83.5	Sept.	1908
16812	**08880**	Nkl. Kys Cyl. gb. Time of Flight 1/100 sec. No mins. S. Smith	Special		July	1916
16813	**08881**	Nkl. Kys Cyl. gb. Time of Flight 1/100 sec. S. Smith	Special		July	1916
11097	**08895**	G. Kys ¾ pl. Karrusel sr. gb.	A	76.6	June	1902
11207	**08895**	,,	A.eg	80.3	Oct.	1902
10315	**08900**	S. Kys ½ pl. gb.	A	69.0	May	1902
11163	**08900**	,,	A.eg	81.8	Aug.	1902
11152	**08901**	S. Kys ¾ pl. sr. gb. Karrusel	A	66.8	Aug.	1902
11127	**08905**	S. Kys ¾ pl. sr. gb. Karrusel	A	69.0	July	1902
11782	**08922**	G. Kys ¾ pl. min. & split cg. min. rep. dr. gb. Lever Tourbillon	A.eg	85.6	Feb.	1904
11107	**08928/10866**	G. Kys ¾ pl. sr. gb. Lever Tourbillon	A.eg	83.5	June	1902
11330	**08948**	G. Kys ¾ pl. sr. gb. Karrusel	A	65.7	Feb.	1903
11493	**08948**	,,	A	79.1	July	1903
11309	**08949**	G. Kys ¾ pl. sr. gb.	A.eg	84.6	Jan.	1903
13255	**08949**	S. Kys ½ pl. sr. gb. Karrusel "Traveller"	A.eg	80.2	May	1908
11170	**08959/55170**	S. Kys ¾ pl. sr. gb. cent. secs. Karrusel	A.eg	82.1	Sept.	1902
11382	**08960**	S. Kys ½ pl. dr. gb.	A.eg	80.2	March	1903
11609	**08964**	G. Kys ¾ pl. sr. gb. Lever Tourbillon	A.eg	80.7	Sept.	1903
11712	**08964**	,,	A.eg	89.8	Dec.	1903
11482	**08966**	S. Kys ¾ pl sr. gb.	B		May	1903
11483	**08967**	S. Kys ¾ pl. sr. gb.	B		May	1903
	08978	G. Kys ¾ pl. sr. gb. Lever Tourbillon	A	66.4	Sept.	1903
12396	**08978**	,,	A	74.5	Aug.	1905
12613	**08978**	,,	A.eg	82.4	Nov.	1905

11077	**08982/31325**	G. Kys ¾ pl. dr. gb. Karrusel	A.eg	83.1	June	1902
11925	**08983**	Cylinder gb. Fly-back ch. 2 dials secs. & 100 sec. (Speed of Flight) Submitted by Armstrong Whitworth & Co.			April	1904
11926	**001**	As above. No number on it, so Armstrong Whitworth engraved '001' on its dial after the trial			April	1904
12189	**08991**	G. Kys ¾ pl. dr. fusee Tourbillon lever	A.eg	81.3	Jan.	1905
12279	**08991**	,,	A.eg	90.1	May	1905
13599	**08991**	,,	A.eg	85.5	June	1909
16731	**08991**	,,	A.eg	89.9	June	1916
13655	**08992**	G. Kys ¾ pl. dr. fusee Tourbillon lever	A.eg	80.6	Aug.	1909
13740	**08992**	,,	A.eg	82.9	Nov.	1909
13806	**08992**	,,	A.eg	87.2	Jan.	1910
15646	**08992**	,, N.N.	A.eg	83.3	Aug.	1913
11613	**09050/56909**	G. Kys ¾ pl. sr. gb. Karrusel Bonniksen	A.eg	87.5	Oct.	1903
11559	**56998**	G. Kys ¾ pl. sr. gb. Karrusel. Bonniksen	A.eg	82.9	Aug.	1903
11040	**57896**	G. Kys ½ pl. dr. gb.	A.eg	81.8	Aug.	1902
12009	**09060**	G. Kys ½ pl. sr. gb. Lever Tourbillon	A	79.5	July	1904
12102	**09060**	,,	A	75.6	Oct.	1904
12190	**09060**	¾ ,,	A.eg	81·6	Jan.	1905
12154	**09072**	S. Kys ¾ pl. sr. gb. Tourbillon	A.eg	83.0	Dec.	1904
12824	**09082/51606**	G. Kys ½ pl. dr. gb. Annular Tourbillon. Carley & Clemence per Taylor	A.eg	88.1	Oct.	1906
12373	**09097**	G. Kys ¾ pl. sr. gb. Karrusel	A.eg	83.1	July	1905
12724	**09097**	,,	A.eg	83.3	June	1906
14085	**09097**	,,	A.eg	88.3	Aug.	1910
12612	**09099**	G. Kys ¾ pl. sr. gb. Tourbillon lever	A	78.7	Nov.	1905
12666	**09099**	,,	A	79.2	March	1906
12766	**09099**	,,	A.eg	82.9	July	1906
12192	**09128/90119**	G. Kys. ¾ pl. dr. fusee Min. rep. Tourbillon	A.eg	87.0	Jan.	1905
12808	**09133**	G. Kys ¾ pl. dr. fusee Tourbillon lever	A.eg	90.8	Sept.	1906
27378	**09133**	,, C. Essex, Esq.	A		May	1946

12085	**09145/11137**	G. Kys ½ pl. dr. fusee Min. rep	A	78.5 Sept.	1904
13102	**09152**	G. Kys ½ pl. dr. gb. min. 7 split cg. min. rep. Tourbillon	A.eg	83.0 Oct.	1907
13068	**09171**	G. Kys ¾ pl. dr. fusee Tourbillon lever	A.eg	89.3 July	1907
13115	**09171**	,,	A.eg	89·6 Oct.	1907
12856	**09182/11487**	G. Kys ½ pl. dr. fusee Tourbillon lever	Ae.g	93.9 Nov.	1906
12839	**09190/12127**	S. Kys ½ pl. dr. gb. Lever Tourbillon	A.eg	84.3 Oct.	1906
13116	**09247/11403**	S. Kys ½ pl. sr. gb.	A	76.7 Oct.	1907
13711	**09256**	G. Kys ½ pl. dr. gb. min. & split sec. cg. Tourbillon	A.eg	81.2 Nov.	1909
14383	**09256**	¾ ,, N.N.	A	79.7 March	1911
13598	**09269/12166**	G. Kys ¾ pl. dr. fusee Tourbillon lever N.N.	A.eg	91.8 June	1909
13848	**09319/11421**	S. Kys ½ pl. sr. gb. Traveller N.N.	A.eg	84.4 Nov.	1909
14356—09325		G. Kys ¾ pl. dr. gb. min. & split sec. cg. min. rep. N.N.	A	73.1 March	1911
17343	**09364**	G. Kys ¾ pl. dr. gb. Tourbillon North & Son.	A.eg	88.6 Jan.	1919
14254	**09365/12194**	S. Kys ¾ pl. dr. fusee Tourbillon lever N.N.	A.eg	92.5 Dec.	1910
14355	**09416/12167**	S. Kys. ¾ pl. dr. gb. Tourbillon lever N.N.	A.eg	91.6 March	1911
15024	**09428**	G. Kys ½ pl. dr. gb. ¼ rep. Tourbillon N.N.	A	75.8 April	1912
15146	**09428**	,, N.N.	A	61.6 Aug.	1912
15570	**09513**	G. Kys ¾ pl. dr. gb. Tourbillon N.N.	A.eg	80.2 June	1913
15685	**09513**	,, N.N.	A.eg	88.6 Sept.	1913
17809	**09513**	,, Guillaume Balance North & Son	A.eg	87.3 Dec.	1920
16070	**09562/12172**	G. Kys ¾ pl. dr. fusee Tourbillon N.N.	A.eg	91·7 June	1914
16724	**09573/12168**	S. Kys ¾ pl. dr. fusee Tourbillon Invar balance N.N.	A.eg	92.4 May	1916
19993	**09597**	Time of Flight 1/100 cylinder gb. Woolwich Arsenal Special		Feb.	1930
16900	**09655/12174**	S. Kys ¾ pl. dr. fusee Tourbillon Invar Bal. N.N.	A.eg	90.6 Dec.	1916
26961	**09655/12174**	,, T. E. White, Isleworth Failed		July	1945

27204	**09655/12174**	„	Endorsed		Jan.	1946
29726	**09655/12174**	„	Endorsed		March	1948
16902	**09672**	G. Kys ¾ pl. sr. gb. Revolving Escapement	N.N. A	71.2	Dec.	1916
17123	**09672**	„ Mainspring failed	North & Son None		Sept.	1917
17130	**09672**	„	A	66.4	Nov.	1917
17230	**09672**	G. Kys ¾ pl. sr. gb. Karrusel	North & Son A.eg	82.9	May	1918
17122	**09692**	G. Kys ¾ pl. dr. fusee Tourbillon Invar balance.	North & Sons A.eg	86.7	Oct.	1917
17163	**09692**	G.Kys ¾ pl. dr. fusee Tourbillon Guillaume bal.	North & Sons A.eg	92.1	March	1918
17202	**09780/12178**	G. Kys ¾ pl. dr. fusee Tourbillon Guillaume bal.	North & Sons A.eg	91.7	April	1918
18049	**09820**	G. Kys ¾ pl. dr. fusee Tourbillon	North & Sons A.eg	83.1	May	1922
18605	**09831**	S. Kys ¾ pl. dr. fusee Tourbillon Guillaume bal.	North & Sons A.eg	88.8	Aug.	1924
18394	**09850**	G. Kys ½ pl. dr. fusee Tourbillon	North & Sons A.eg	80.2	Dec.	1923
18484	**09850**	„	North & Sons A.eg	88.5	March	1924
28318	**09850**	„	T. E. White Endorsed		April	1947
25709	**09854**	G. Eng. Chronog 1/5 sec. 60 mins. Special Test Report issued	Clowes & Jauncey		Dec.	1942
18717	**09936**	G. Kys ½ pl. dr. fusee Revolving Escapement U & D	North & Sons A.eg	88.6	Jan.	1925
14363	**09941/11652**	S. Kys ¾ pl. dr. gb.	N.N. A.eg	80.5	March	1911
18854	**09947**	S. Kys ¾ pl. sr. gb. Traveller	North & Sons A	76.2	June	1925
18823	**09948**	G. Kys ¾ pl. dr. fusee Revolving Escapement	North & Son A	89.2	May	1925
18918	**09961**	Nickel Time of Flight 1/00 sec. cylinder ¾ pl. gb. Special	North & Sons		June	1925
18938	**09961**	„ „	„ Special		June	1925
18948	**09961**	Nickel Time of Flight 1/00 sec. 1/100 sec. cylinder ¾ pl. gb.	North & Son Certificate		Aug.	1925

19101	**09973/61435**	G. Kys ¾ pl. dr. fusee Tourbillon North & Son A.eg		April	1926
19555	**010295/13583**	G. Ordinary balance. Tourbillon North & Son A.eg	87.4		1928
13743	**119946/11442**	S. Kys ½ pl. sr. gb. Traveller Nicole N. A.eg	84.4	Nov.	1909
17467	**304925**	S. Kys ¾ pl. dr. gb. Peerless North & Son A	78.9	Aug.	1919
17804	**304988**	S. Kys Peerless. Stauffer Son and Co. A.eg	83.5	Dec.	1920
17805	**304989**	S. Kys Peerless. Stauffer Son & Co. A	78.5	Dec.	1920
18198	**35020**	S. Kye ½ pl. sr. gb. North & Sons A	77.3	April	1923
14633	**99765/12246**	G. Kys ¾ pl. sr. gb. Min & Split Chronog. Revolving Esc. Submitted by S. Smith & Son A	70.5	Aug.	1911
14476	**12246**	Was in the name of S. Smith & Son, 9 Strand submitted by N.N. A.eg			

CHARLES FRODSHAM

Marine Chronometer Trials

85	**1893**	2-day Plain balance. Submitted by Thoms. Hewitt B		Sept.	1892
1675	**6450**	2-day Plain balance. Palladium spring Johannsen Cert.		Feb.	1914
2884	**10048**	2-day Aux. Steel spring. C.F. Failed		Jan.	1933
2885	**10048**	2-day. Passed		April	1933
1394	**10056**	2-day Split rim Palladium spring. C.F. None		Feb.	1912
1395	**10058**	2-day „ „ C.F. None		Feb.	1912
2332	**10067/12397**	2-day Plain Bal. Steel spring. T. Mercer Mean v. 128		July	1922
2575	**10068/13175**	2-day Pool's Aux. Palladium sp. T. Mercer Passed		June-Aug.	1927
2648	**10070/13337**	2-day Pool's Aux. Palladium Cont.			1923
2393	**12231**	2-day. T. Mercer		June	1928
2613	**13270**	2-day. T. Mercer Passed		Dec. '27 - Jan.	1928

G. E. FRODSHAM & CO.

Watch Trials

1019	**3447**	S. Kw ¾ pl. fusee Duplex	A		March	1887
237	**14006**	G. Kys Centre Secs. Pocket Chronometer	B		Oct.	1885
9457	**24987**	G. Kys. Min. cg. min. rep. perpet cal. Moon phases	A	70.5	Nov.	1898
9959	**191-226**	G. Kys ¾ pl. sr. Centre secs.	A.eg	80.2	Dec.	1899

PARKINSON & FRODSHAM

Watch Trials

10739	**1091**	G. Kys ½ pl. dr. gb.	A	78.9	Dec.	1901
6935	**6162**	G. Kys ¾ pl. dr. gb. Karrusel	A.eg	86.7	Nov.	1894
685	**6660**	G. Kys ½ pl. Pocket chronometer	A.eg	83.6	Aug.	1886
13162	**7273**	S. Kys ¾ pl. sr. gb. Karrusel	A.eg	84.1	May	1909
13540	**7272**	S. Kys ¾ pl. sr. gb. Karrusel	A.eg	84.4	Jan.	1908
1124	**26456**	S. Kys ¾ pl. Min. & sec. cg. gb. made by Baume & Co.	A	75.1	July	1887
2759		Subsidiary trial. Action still good			March	1890
11090		„ „ Papers endorsed			June	1902
11545		„ „	None		June	1903
11569		„ „ Papers endorsed			July	1903
10062	**52999**	G. Kys ¾ pl. Min. Chronog. dr. gb.	A	74.4	March	1900
5306	**278413**	S. Kys ¾ pl. sr. gb.	B		March	1893

PARKINSON & FRODSHAM

Marine Chronometer Trials

144	**4154**	2-day 4-arm balance. Submitted by Rob. Gardner.	A	April	1894
486	**4164**	2-day Plain balance. P. & F.	B	April	1899
188	**4182**	2-day Poole's auxiliary. Submitted by Thoms. Hewitt	A	June	1895
409	**4201**	2-day Palladium spring. P. & F.	A	Jan.	1899
1675	**6450**	2-day Johannsen. P. & F.	Cert.		1914

FRODSHAM & KEEN

Marine Chronometer Trials

95	**3833**	2-day Ordinary balance Submitted by	T. Mercer B	April	1893
96	**3834**	2-day	T. Mercer B	April	1893
1083	**2733**	8-day Split rims.	T. Mercer A	Dec.	1908
1298	**3884/8438**	2-day Palladium spring	T. Mercer A	March	1911
1299	**8444**	2-day Palladium spring	T. Mercer None	Feb.	1911
1410	**3893/8654**	2-day Palladium spring	T. Mercer A	March	1912
1411	**8658**	2-day Split rim. Palladium	T. Mercer None		8.2.1912
1412	**8569**	2-day Split rim. Palladium	T. Mercer None		8.2.1912

APPENDIX XV

CHRONOMETER RECORDS, GREENWICH

THE following extracts come from the Chronometer Ledgers of the Royal Observatory, Greenwich, and contain the records of the use of the various Frodsham marine chronometers, pocket chronometers, deck watches and hack watches belonging to the Government. The notes concerning the times when these instruments were returned to the maker have nearly all been omitted, and likewise most of the records concerning the times when they were at Portsmouth, Devonport or Sheerness.

The page numbers refer to the number of the page in the Chronometer Ledgers from which these records have been extracted.

It is by the courtesy of the Controller of H.M. Stationery Office on behalf of the National Martime Museum, Greenwich that I have been permitted to quote this digest.

No. 1		**C. Frodsham.**
1 Oct.	1831	Greenwich. Page 294
30 Nov.	1831	Raven. Lt. Arlett.
12 Dec.	1833	Wasp. Capt. Burney.
2 Oct.	1837	Rhadamanthus.
10 May	1845	Erebus. Lost in the Erebus with Sir John Franklin.
26 Jan.	1886	Taken off books.
No. 2		**C. Frodsham.**
6 Dec.	1831	Beagle. Capt. Stokes. Page 291
30 Nov.	1831	Etna. Capt. Belcher.
7 Nov.	1833	Etna.
4 May	1848	H.M.S. Ranger.
6 March	1865	Rokeby Winder applied.
7 Feb.	1874	H.M.S. Nimble.
21 Aug.	1877	H.M.S. Charybdis. Page 1428
3 Oct.	1879	H.M.S. Victor Emanuel.
12 Oct.	1880	H.M.S. Zephyr.
7 Feb.	1889	H.M.S. Leander.
2 July	1892	H.M.S. Victor Emanuel.
28 March	1893	Colaba, Bombay.
14 June	1897	H.M.S. Thetis.
3 Nov.	1900	H.M.S. Condor. Lost in H.M.S. Condor.
8 April	1902	Cut off books.

No. 0003		**C. Frodsham.** Purchased Sept. 1884 from the makers. No. 2, Annual trial 1884.
22 July	1890	H.M.S. Grasshopper. Page 1505
7 Jan.	1904	H.M.S. Renard.
24 Feb.	1905	H.M.S. Hecla.
20 Jan.	1915	H.M.S. Crescent
25 Feb.	1916	Malta.
6 June	1916	Immingham.
23 March	1922	Hong Kong.
23 May	1924	Malta. Page 9738
1 Dec.	1925	Bermuda.
30 Dec.	1925	S/S Buckworth.
12 Aug.	1927	H.M.S. Cornwall.
29 March	1930	Hong Kong.
2 Dec.	1930	Lindguist.
No. 0011		**C. Frodsham.** Purchased July 1887 from the maker. No. 3 special trial 1887.
24 Feb.	1888	H.M.S. Stork. Page 1580
30 Dec.	1891	H.M.S. Gannet.
19 Nov.	1895	Cape of Good Hope.
9 March	1908	H.M.S. Skipjack.
16 April	1909	Malta.
2 Aug.	1918	Usher and Cole. Sold to Messrs. Usher and Cole.

No. 40 **Frodsham.**
Purchased 1920 Ex. H.M.S. Raytavet. See Hyd. letter June 28, 1920.

6 July 1920 Malta. Page 9606
Aug. 1930 Sold to Kelvin White and Hutton. See Hyd. letter Aug. 10, 1920.

No. 389 **Charles Frodsham. Pocket.**
Formerly belonging to the Colonial Office. See letter 21 Dec., 1846.

10 May 1848 H.M.S. Investigator. Page 719
22 June 1850 H.M. Surveying Vessel Asp.
21 Feb. 1852 Lieut. Alldridge.
23 April 1852 H.M.S. Milford.
8 Feb. 1858 Capt. Washington, R.N.
1 Sept. 1858 Col. Moody for the use of the Expedition to British Columbia.
Col. Moody exped. B. Columbia. Paid for.

No. 414 **C. Frodsham. Pocket.**
Purchased Jan. 6, 1842.

7 March 1842 Fly. Page 568
Hydrographer Reports. "Used in H.M.S. Fly 1842, not the property of the Government".

No. 1348 **C. Frodsham.**
Ship's Speed.

29 May 1894 Portsmouth. Page 2015
15 Aug. 1912 Mr. Eddington for Eclipse Expedition.
18 June 1913 C. Davidson, Esq., for Eclipse Expedition.
July 1914 R.O. Eclipse Expedition to Russia.
28 April 1923 Received from Russia.

No. 1482 **C. Frodsham.**
Purchased Aug. 7, 1845.

22 Nov. 1845 Retribution Page 676
30 Aug. 1886 H.M.S. Woodlark.
9 July 1889 H.M.S. Cyclops.
6 Aug. 1891 H.M.S. Buzzard.
1 Feb. 1897 H.M.S. Monarch.
14 July 1902 Cape of Good Hope.
5 Jan. 1905 H.M.S. Pegasus.
19 March 1907 Sydney Depot.
18 Feb. 1911 Cape Observatory.
26 April 1922 H.M.S. Warspite. Page 3894
6 July 1925 Sold to Messrs. A. Johannsen and Co.

No. 1485 **C. Frodsham.**
Purchased Aug. 26, 1846

11 Jan. 1847 Birkenhead. Page 709
4 Aug. 1852 H.M.S. Medusa.
24 Nov. 1862 Admiral Washington.
11 Feb. 1869 H.M.S. Pandora.
17 March 1880 H.M.S. Pelican.
15 Feb. 1882 H.M.S. Phoenix.
20 June 1893 H.MS Goldfinch
28 Aug. 1894 Sydney.
29 Dec. 1898 H.M.S. Repulse.
21 Jan. 1904 H.M.S. Repulse. Page 3080
16 May 1904 H.M.S. Prince of Wales.
22 Dec. 1925 Sold to Mr. F. M. Vowell.

No. 1540 **C. Frodsham.**
Purchased Aug. 7, 1845.

25 Nov. 1845 H.M.S. Lizard. Page 677
19 June 1850 H.M.S. Dolphin.
12 March 1854 H.M.S. Rosamund.
8 Jan. 1860 H.M.S. Basilisk.
26 May 1863 H.M.S. Columbine.
30 April 1864 H.M.S. Bombay.
Lost in the "Bombay"

No. 1681 **C. Frodsham.**
Purchased July 19, 1838

17 Jan. 1847 Samarang. Page 427
26 Nov. 1850 H.M.S. Fairy.
13 July 1855 H.M.S. Hermes.
6 June 1860 H.M.S. Monarch.
24 Dec. 1862 H.M.S. Pylades.
31 Jan. 1876 H.M.S. Repulse.
22 June 1878 H.M.S. Albatross.
23 April 1879 H.M.S. Gannet.
6 Nov. 1885 H.M.S. Audacious.
13 May 1890 H.M.S. Thrush
1 Jan. 1895 Cape of Good Hope Page 2066
3 Feb. 1905 Bombay.

27 Aug.	1906	E. Dent and Co. Taken in exchange by E. Dent and Co. for new Hack watches.
No. 1686		**C. Frodsham.** Purchased Sept., 1841.
13 Oct.	1841	Portsmouth. Page 532
13 May	1844	Transport Pertongee Bonnenger.
15 Aug.	1845	H.M.S. Crocodile.
15 May	1861	H.M.S. Formidable.
9 Dec.	1863	H.M.S. Conqueror.
18 June	1886	China.
26 May	1893	Capt. Jackson.
6 Feb.	1894	H.M.S. Urgent.
9 Jan.	1908	H.M.S. Dwarf. Page 3250
10 July	1914	Gibraltar Depot
21 Jan.	1915	M.F.A. Richard
4 Feb.	1915	Welford.
16 June	1915	S.N.O. Tyne.
9 Dec.	1919	H.M.S. M16.
1 March	1920	Malta. Sold to Mr. A. N. Anderson.
No. 1704		**C. Frodsham.** Came in H.M.S. Adventure from China in Nov. 1873, to be used on Goverment Service.
10 July	1874	H.M.S. Flying Fish. Page 1359.
5 May	1879	Colaba Observatory, Bombay.
25 Oct.	1884	H.M.S. Dryad.
19 June	1888	H.M.S. Benbow.
21 May	1896	Malta.
9 June	1897	H.M.S. Victorious.
15 Jan.	1903	H.M.S. Hawke.
25 Feb.	1905	Sydney.
28 April	1916	Malta. Page 3551
5 Oct.	1916	Usher and Cole. Exchanged for Usher and Cole H.W. No. 30139.
No. 1715		**C. Frodsham.** Purchased Aug. 24, 1840.
23 Sept.	1840	Medea. Page 481
20 July	1843	H.M.S. Howe.
3 Jan.	1844	Vestal.
6 May	1853	H.M.S. Phoenix.
12 Oct.	1854	Arctic Expedition.
4 Sept.	1855	H.M.S. Castor.
15 Feb.	1859	H.M.S. Waterloo.
13 Nov.	1860	H.MS. Charybdis.
28 July	1866	H.M.S. Industry.
28 Aug.	1878	H.M.S. Alert.
11 Sept.	1882	H.M.S. Duncan.
22 June	1887	H.M.S. Sphinx.
4 Oct.	1900	H.M.S. Thunderer. Page 1847
13 July	1904	Naval Manoeuvres.
27 Oct.	1905	Sydney Depot.
26 May	1914	Hong Kong.
5 May	1919	T.S.O. Birkenhead.
1 March	1920	Sold to A. N. Anderson.
No. 1752		**Charles Frodsham.** Notice of Purchase Nov. 6, 1839.
12 Sept.	1839	Terror. Page 466
20 March	1849	Espiegle.
3 June	1850	H.M.S. Resistance.
29 July	1858	H.M.S. Firefly.
3 July	1867	H.M.S. Viper.
9 June	1874	Transit of Venus.
28 Jan.	1882	T.O.V. Canada.
30 June	1894	Cape of Good Hope. Page 1694
25 Feb.	1896	Malta.
31 March	1900	H.M.S. Hood.
29 July	1903	H.M.S. Highflyer.
13 Nov.	1909	Exchanged for Hack Watches E. Dent & Co.
No. 1765		**Charles Frodsham**
12 Sept.	1839	Erebus. Page 467
16 Aug.	1848	H.M.S. Acorn.
19 June	1856	Professor Smyth.
10 Nov.	1856	Adjusted to Mean Solar Time.
17 Feb.	1857	H.M.S. Iris.
5 Aug.	1861	H.M.S. Formidable.
22 March	1872	H.M.S. Challenger.
28 March	1893	H.M.S. Tourmaline.
23 Sept.	1895	H.M.S Victor Emanuel Page 1927
23 Feb.	1899	Hong Kong
8 March	1901	HM.S. Perseus.
30 May	1902	Bombay.
26 July	1912	Hong Kong. Page 3972
11 April	1916	Naval College Dartmouth.

No. 1768		**C. Frodsham.** Purchased Jan. 6, 1842.
14 March	1842	Growler. Page 575
11 Nov.	1850	H.M.S. Rattlesnake.
22 March	1852	H.M.S.V. Antelope.
8 Oct.	1861	H.M.S.Recruit.
18 Nov.	1873	H.M.S. Charybdis.
12 June	1884	H.M.S. Turquoise.
9 July	1889	H.M.S. Hydra.
28 Aug.	1894	Sydney. Page 1928
26 Sept.	1898	H.M.S. Renown.
13 Oct.	1903	Malta.
1 July	1904	H.M.S. Brisk.
13 March	1907	Taken in exchange by E. Dent and Co. for new Hack watches.
No. 1788		**C. Frodsham.** Purchased July, 1864 from Mrs. Roberts.
20 Aug.	1872	North American Boundary Commission. Page 1154
20 Sept.	1883	H.M.S. Flying Fish
6 June	1893	H.M.S. Hood.
31 Oct.	1898	Hong Kong.
29 March	1906	H.M.S. Vindictive. Page 2941
30 April	1917	H.M.S. Boadicea.
8 Sept.	1919	H.M.S. Hermione.
1 March	1920	Sold to Mr. A. N. Anderson.
No. 1806		**C. Frodsham.** Purchased Sept. 1841.
13 Oct.	1841	Portsmouth. Page 530
13 June	1853	H.M.S. Nerbudda.
	1853	Lost in wreck of H.M.S. " Nerbudda ".
No. 1809		**C. Frodsham.** Purchased Dec. 28 1841
10 Nov.	1846	Grasshopper. Page 556
18 June	1846	Grappler.
30 May	1856	Altered to Sidereal Time.
19 June	1856	Professor Smyth.
10 Nov.	1856	Adjusted to Mean Solar Time.
17 Feb.	1857	H.M.S. Iris for conveyance to the Cape Observatory.
5 June	1860	H.M.S. Monarch.
2 Aug.	1867	H.M.S. Vestal.
15 May	1878	H.M.S. Rifleman.
17 Dec.	1880	H.M.S. Champion.
5 Jan.	1905	H.M.S. Argonaut. Page 2575
10 Feb.	1915	H.M.S. Laurentic.
Feb.	1915	H.M.S. Challenger.
22 Aug.	1916	H.M.S. Dwarf.
1 March	1920	Sold to Mr. A. N. Anderson.
No. 1826		**C. Frodsham. 8-day.** Purchased Dec. 28 1841
9 Sept.	1852	Cape Survey. Page 558
20 Sept.	1872	S. Australian Survey.
28 Aug.	1873	Transit of Venus Observers.
14 May	1875	Arctic Expedition.
22 Nov.	1877	H.M. Schooner "Lark".
17 Sept.	1884	H.M.S. Sparrow Hawk.
2 July	1891	Cape of Good Hope.
29 Oct.	1897	Malta.
16 June	1903	H.M.S. Sappho.
18 Aug.	1920	Sold to Mr. F. Parker Wood. Page 4087
No. 1842		**C. Frodsham.** Purchased Mar. 6 1841.
10 April	1841	H.M.S.V. Wilberforce. Page 509
25 Sept.	1857	H.M.S. Waterloo.
29 July	1878	H.M.S. Ready.
27 Sept.	1880	Cape of Good Hope Depot.
14 Jan.	1884	H.M.S. Myrmidon.
4 April	1889	West Coast of England survey.
23 Sept.	1895	H.M.S. Victor Emanuel.
24 May	1916	H.M.S. Doris. Page 3008
28 Aug.	1916	Gibraltar.
10 Oct.	1922	Sold to Messrs. Usher and Cole.
No. 1957		**C. Frodsham. 2-day.** Purchased Aug. 15 1843.
29 June	1850	H.M.S. Volage. Page 627
6 March	1851	H.M.S. Bonetta.
18 Sept.	1855	H.M.S. Transport Urgent.
8 March	1860	H.M.S. Nile.

6 Aug.	1861	H.M.S. Wanderer.
15 Aug.	1866	H.M.S. Nassau.
17 Feb.	1874	H.M.S. Magpie.
7 June	1883	Naval Depot Sydney
12 Jan.	1911	Malta. Page 2992
6 Sept.	1921	Malta.
6 April	1929	Sold to Mr. W. Cardall.

No. 2066 — **C. Frodsham.** Purchased Sept. 1847.

20 Dec.	1847	H.M.S. Acheron. Page 727
4 Feb.	1868	H.M.S. Blanche.
8 Oct.	1919	Gibralter. Page 3900
1 March	1920	Sold to Mr. A. N. Anderson.

No. 2074 — **C. Frodsham.** Purchased Sept. 8 1847.

20 Dec.	1847	H.M.S. Acheron. Page 720
23 Jan.	1874	H.M.S. Sylvia.
10 Oct.	1882	H.M.S. Thetis.
23 Sept.	1886	Torpedo Boat No. 21.
29 April	1887	H.M.S. Wasp. Lost in "Wasp" Sept. 1887.

No. 2241 — **C. Frodsham.** Purchased Oct. 20 1865 from Capt. Strode.

25 Oct.	1882	H.M.S. Inconstant. Page 1215
3 Dec.	1883	H.M.S. Forward.
13 Jan.	1893	H.M.S. Beagle.
26 May	1904	H.M.S. Exmouth.
6 June	1911	Malta. Page 3875
23 Aug.	1917	H.M.S. Ramilles.
26 April	1937	Sold to P. Webster.

No. 2349 — **C. Frodsham.** Purchased June 1866 from H. Baker, Esq., at Ningpo.

2 Oct.	1886	H.M.S. Britannia. Page 1437
29 July	1889	H.M.S. Medusa.
11 Sept.	1890	H.M.S. Dolphin.
21 Dec.	1898	Bermuda.
29 June	1914	H.M.S. Colossus.
24 April	1918	Malta. Page 4813 Lost in H.M.S. Kinross. Hyd. letter Oct. 7 1921.

No. 2564 — **C. Frodsham.** Purchased of Capt. Rice. Dec. 6 1860.

16 March	1867	H.M.S. Hydra. Page 999
26 Nov.	1883	H.M.S. Victor Emanuel.
29 Dec.	1891	H.M.S. Linnet.
20 Aug.	1897	H.M.S. Victor Emanuel.
22 Dec.	1902	Hong Kong.
5 April	1905	H.M.S. Tamar.
11 April	1908	H.M.S. Lancaster.
17 Nov.	1914	Commander Haddock, R.N. (c/o Harland and Wolff, Ltd.). Page 3434
26 Oct.	1915	H.M.S. "No. 1" from S. D. Neill, Belfast.
11 Jan.	1916	H.M.S. Cochrane.
26 April	1919	J. T. Eltringham and Co, Job No. 339.
17 Aug.	1923	Malta.
14 Jan.	1927	H.M.S. Tiger.
6 Feb.	1930	Sold to Aircraft Operating Co. Ltd.

No. 2655 — **C. Frodsham.** In exchange 1855.

11 June	1857	H.M.S. Waterloo. Page 807
18 Nov.	1857	H.M.S. Spitfire.
14 Aug.	1861	Commander Hutchison.
3 Dec.	1878	Cape Observatory.
14 Oct.	1889	Malta.
24 July	1893	H.M.S. Victor Emanuel.
28 Sept.	1894	H.M.S. Bullfrog.
24 Dec.	1897	Malta
5 May	1899	H.M.S. Partridge.
14 July	1902	Cape of Good Hope.
23 Feb.	1909	Malta.
9 June	1913	Malta. Page 3716
19 Dec.	1914	Esquimalt Depot.
5 March	1918	Gibraltar.
30 Dec.	1924	Malta.

No. 2714 — **C. Frodsham.** Purchased 7 Sept. 1855. For Earnshaw 543.

18 Feb.	1856	H.M.S. Tartarus. Page 820
26 Sept.	1874	H.M.S. Audacious.
30 May	1881	H.M.S. Inconstant.
7 July	1891	H.M.S. Barracouta.
23 Feb.	1892	H.M.S. Blake.
18 April	1900	Malta.

28 June 1903 Hong Kong.
17 April 1914 Bermuda. Page 3433
28 July 1919 H.M.S. Instance.
29 Aug. 1919 H.M.S. Hermione.
6 Feb. 1920 Sold to U.S. Shipping Board.

No. 2715 **C. Frodsham.**
Purchased Sept. 1871 from Capt. Haswell.
31 Jan. 1876 H.M.S. Repulse. Page 1328
15 July 1878 H.M.S. Belleisle.
18 Feb. 1890 H.M.S. Warspite.
28 June 1893 H.M.S Champion
29 Jan. 1894 H.M.S. Stork.
26 July 1896 Malta.
29 March 1899 H.M.S. Warspite.
Lost in H.M.S. Indefatigable. Page 3437
See Hydr. letter 6 April 1918.

No. 2716 **C. Frodsham.**
Purchased Sept. 7 1855.
17 March 1856 H.M.S. Tyne. Page 821
5 Oct. 1857 H.M.S. Avon.
13 Aug. 1874 H.M.S. Nassau.
24 June 1881 H.M.S. Magpie.
9 Nov. 1893 H.M.S. Barracouta
14 July 1902 Cape of Good Hope.
6 Jan. 1905 H.M.S. Repulse.
11 April 1918 Bombay. Page 4146
17 Sept. 1923 H.M.S. Veronica.
1 Feb. 1929 H.M.S. Carysfort.
1 Nov. 1929 H.M.S Calypso.
23 May 1932 Sheerness.

No. 2741 **C. Frodsham.**
Purchased Aug. 5 1916 from Yacht Clementina.
26 June 1916 S.N.O. Larne Harbour. Page 6999
Sold to Clan Line Co. Hyd. Letter Sept. 27 1921.

No. 2764 **C. Frodsham.**
(In exchange for Arnold 503; see letter March 15 1856).
2 Dec. 1856 H.M.S. Dee. Page 827
5 June 1860 H.M.S. Monarch.
14 Dec. 1865 H.M.S. Supply
17 Feb. 1874 H.M.S. Merlin.
16 Jan. 1877 H.M.S. Vulture.
29 Oct. 1881 H.M.S. Diamond.
26 March 1885 H.M.S. Tamar.
11 Sept. 1885 H.M.S. Rifleman
11 Sept. 1890 H.M.S. Edinburgh.
29 Oct. 1894 H.M.S. Victor Emanuel.
14 June 1898 Hong Kong Depot.
21 Jan. 1902 H.M.S. Cockatrice.
12 May 1904 H.M.S. Theseus. Page 3068
20 July 1915 H.M.S. Marigold.
16 Nov. 1926 Bombay.

No. 2767 **C. Frodsham.**
Received in exchange for Arnold 578, Aug. 21 1856.
27 Dec. 1856 H.M.S. Dee. Page 836
7 Jan. 1858 H.M.S. Industry.
15 Dec. 1864 H.M.S. Trident.
27 Dec. 1865 H.M.S. Wolverine.
14 Oct. 1886 Victor Emanuel.
18 Oct. 1894 H.M.S. Pylades. Page 1926
22 Feb. 1916 H.M.S. Tiger.
9 April 1918 H.M.S. Alsatian.
26 April 1937 Sold to P. Webster.

No. 2978 **C. Frodsham.**
Purchased Mar. 13 1858.
1 Feb. 1859 H.M.S. Dee. Page 877
27 April 1868 H.M.S. Philomel.
12 July 1879 H.M.S. Tyrian.
13 July 1883 H.M.S. Dido.
24 July 1893 H.M.S. Victor Emanuel.
3 Feb. 1894 Sydney.
30 April 1895 H.M.S. Dart.
20 Aug. 1896 Malta. Page 2727
4 March 1911 Transferred to Canadian Government.
Cut off books.

No. 3022 **C. Frodsham.**
This chronometer together with McCabe No. 521 was returned from Bombay Observatory in the Indian Troop Ship Malabar; received from them in lieu of 2 Government (Admiralty) chronometers and to be treated as Government property. See Capt. Evans's letter June 28th 1871.

12 June	1882	H.M.S. Iron Duke. Page 1319
26 Nov.	1883	H.M.S. Victor Emanuel.
11 Sept.	1890	H.M.S. Edinburgh.
28 Aug.	1894	Sydney.
11 July	1901	H.M.S. Hawke.
19 Dec.	1905	Malta.
27 Nov.	1914	H.M.S. Laurentic. Page 3356 Lost in H.M.S. Polynnia. See letter 12 May, 1919.

No. 3041 **C. Frodsham.** Purchased Feb. 12 1858, for the Colonial Office.

2 March	1858	Beddingfield for the Colonial Vessel Pearl. Page 874

No. 3139 **C. Frodsham. Pocket.** Purchased April 1859.

5 Dec.	1859	Mr. T. Maclear, Esq. Page 910
16 Aug.	1869	Cape of Good Hope.
3 Aug.	1871	H.M. Surveying Ship Shearwater.
24 Oct.	1876	Capt. C. Warren, R.E.
9 Sept.	1879	Royal Naval College, Greenwich.
15 Jan.	1886	H.M.S. Rambler.
10 Jan.	1890	H.M.S. Egeria.
15 Nov.	1897	H.M.S. Rambler.
6 Feb.	1901	H.M.S. Rambler.
13 Oct.	1903	Hong Kong.
24 May	1904	H.M.S. Goldfinch.
7 Nov.	1907	H.M.S. Sealark.
8 May	1913	Sydney. Page 4096
15 Oct.	1815	Usher and Cole in exchange for Hack Watches.

No. 3140 **C. Frodsham. 2-day.** Purchased May 1860.

6 June	1860	Bulldog. Page 945
25 July	1874	H.M.S. Bullfinch.
5 May	1879	Colaba Observatory, Bombay.
14 Jan.	1889	H.M.S. Myrmidon.
8 Feb.	1900	Sydney.
30 July	1906	H.M.S. Swiftsure. Transferred to Australian Commonwealth. See Hydrographer's letter 1914, March 26th.

No. 3156 **C. Frodsham.** Purchased Nov. 1861 (Arnold 413 and 28 being given in exchange).

20 Sept.	1883	H.M.S. Flying Fish. Page 1039
17 Feb.	1890	H.M.S. Colossus.
10 July	1894	H.M.S. Barfleur.
21 Feb.	1901	H.M.S. Harrier. Page 2640
1 June	1915	H.M.S. Robert E. Lee. Lost in H.M.S. Raglan. See letter 2 Feb. 1920.

No. 3169 **C. Frodsham. 2-day.** Purchased May 1860.

28 March	1865	H.M.S. Megaera. Page 943
3 Jan.	1871	H.M.S. Pert.
14 Oct.	1886	H.M.S. Victor Emanuel.
15 Feb.	1896	Malta.
11 July	1901	H.M.S. Imperience.
18 May	1916	Sydney. Page 6953 Transfer to the Australian Government. See Hyd. letter Aug. 24 1921

No. 3170 **C. Frodsham. 2-day.** Purchased May 1860.

30 Nov.	1866	H.M.S. Virago. Page 944
1 April	1873	H.M.S. Rifleman.
30 Jan.	1879	H.M.S. Tyne.
25 Oct.	1882	H.M.S. Dryad.
20 Aug.	1896	H.M.S. Endymion
19 Sept.	1898	HM.S. Tamar.
20 March	1902	Hong Kong.
28 May	1904	H.M.S. Columbine.
5 April	1910	Cape Observatory.
18 Feb.	1914	H.M.S. Ocean. Lost in "Ocean".

No. 3178 **C. Frodsham.** (Arnold 417 given in part exchange June 1860).

15 Aug.	1866	H.M.S. Nassau. Page 956
3 Jan.	1871	H.M.S. Pert.
11 May	1874	Transit of Venus.
9 Aug.	1877	H.M.S. Temeraire.

19 June	1888	H.M.S. Benbow.
2 July	1900	H.M.S. Pioneer.
2 Feb.	1903	H.M.S. Royal Oak.
9 Jan.	1908	H.M.S. Dwarf.
16 May	1916	Gibraltar. Page 4102
19 Aug.	1916	Naval Base, Falmouth.
28 March	1919	U.S.S. Corsair.
25 June	1920	Malta.
18 April	1925	Hong Kong.
21 April	1925	Issued to M.V. Chengtar, China Navigation Co. by Geo. Falcon Ltd., Hong Kong.

No. 3193 **C. Frodsham and Co.**

8 May	1913	Sydney. Page 4096
15 Oct.	1915	Usher and Cole. In exchange for Hack Watches.

No. 3205 **C. Frodsham.** Purchased Sept. 1862.

13 Nov.	1874	Mr. Ellis for use at Porthcurno. Page 1096 (Transit of Venus).
26 July	1875	H.M.S. Diamond.
23 Sept.	1886	Torpedo Boat No. 22.
21 Sept.	1891	Esquimalt.
20 Aug.	1894	H.M.S. Garnet.
7 Dec.	1908	Bombay. Page 3691
14 Feb.	1916	H.M.S. Achilles.
5 May	1916	H.M.S. Bristol. Sold with S.S. Teutonic. Hyd. 24.4.22.

No. 3268 **C. Frodsham.** Purchased Sept. 1862.

7 July	1885	H.M.S. Revenge. Page 1097
26 March	1891	H.M.S. Mild.
11 July	1901	H.M.S. Iphigenea.
9 Sept.	1905	H.M.S. Roxburgh.
27 Feb.	1917	Bermuda.
5 Dec.	1927	Portsmouth. Page 9724

No. 3423 **C. Frodsham.** Purchased Sept. 1871 from C. Frodsham annual competitive trial.

19 Nov.	1879	H.M.S. Salamis. Page 1323
2 July	1900	H.M.S. Skipjack.
18 May	1917	Malta. Page 4071
4 Aug.	1917	H.M.S. Tay and Tyne.
15 April	1919	H.M.S. Truro.
27 Nov.	1922	Malta.
4 Dec.	1930	Plymouth.

No. 3425 **C. Frodsham.** Purchased July 1867 from C. Frodsham.

1 Feb.	1868	H.M.S. Beacon. Page 1263
17 Dec.	1880	H.M.S. Champion.
30 Dec.	1891	H.M.S. Amphion.
27 Feb.	1905	H.M.S. Magnificent.
27 March	1915	H.M.S. Hibernia. Page 3956
26 Feb.	1918	H.M.S. Ophir.
11 Aug.	1919	Gibraltar.
30 Aug.	1922	Bombay.
19 July	1928	Hong Kong.

No. 3432 **C. Frodsham.** Received from Portsmouth 1875 April 9; not known to be Government property. To be retained provisionally as a Government Chronometer.

11 May	1898	Capt. Tizard. Page 1384
2 June	1899	Hong Kong.
8 March	1910	Sydney.
12 Feb.	1914	Portsmouth. Lost in H.M.S. Invincible (see letter April 6 1918).

No. 3446 **C. Frodsham.** Purchased July 1867 from C. Frodsham.

23 Jan.	1874	H.M.S. Sylvia. Page 1264
19 Sept.	1881	P. Chambers, Esq., 'Colaba Observatory.
19 Jan.	1886	H.M.S. Sparrowhawk.
5 March	1889	H.M.S. Bellerophon.
19 April	1892	Mr. Coombes.
8 Feb.	1900	Sydney.
19 Nov.	1907	H.M.S. Venerable.
8 March	1910	Sydney. Page 3680 Transferred to Australian Government. Hyd. letter 21st Aug. 1921.

No. 3449 **C. Frodsham.**
Purchased July 1867 from C. Frodsham.

1 Feb. 1868 H.M.S. Beacon. Page 1265
3 June 1876 H.M.S. Rupert.
14 June 1897 H.M.S. Terpsichore.
21 May 1898 H.M.S. Brisk.
2 March 1917 Hong Kong. Page 3335
21 April 1920 Sheerness.
Presented to Newfoundland Government. See letter Aug. 19th 1920.

No. 3464 **C. Frodsham.**
Purchased Nov. 1874 from Commander Hipperley.

8 June 1876 H.M.S. Fawn. Page 1378
1 Nov. 1879 H.M.S. Albatross.
28 April 1883 H.M.S. Himalaya.
6 Nov. 1883 Cape of Good Hope Observatory.
10 June 1897 H.M.S. Karrakatta.
19 Sept. 1898 Hong Kong Depot.
20 Aug. 1918 Malta.
28 Aug. 1924 Malta. Page 9730
14 Sept. 1928 H.M.S. Caradoc.
8 Sept. 1932 Portsmouth.

No. 3519 **C. Frodsham.**
Purchased March 1875.

31 Jan. 1876 H.M.S. Repulse. Page 1391
16 Jan. 1877 H.M.S. Alexandra.
15 Nov. 1886 H.M.S. Wild Swan.
16 Oct. 1894 H.M.S. Hebe.
24 Dec. 1897 Malta.
23 May 1899 H.M.S. Pomone.
5 Feb. 1906 Bombay.
5 May 1908 H.M.S. Fox.
30 Sept. 1913 H.M.S. Sappho.
28 Nov. 1914 H.M.S. Westward Ho. Page 4815
31 Oct. 1919 Tug St. Hiliary.
16 Feb. 1930 Malta.

No. 3593 **C. Frodsham.**
Purchased Sept. 1 1882 from the makers. Annual trial, 1882.

9 April 1883 H.M.S. Triton. Page 1492
26 March 1890 Sydney.
11 Oct. 1898 H.M.S. Colossus.
25 April 1906 H.M.S. Donegal.
18 Dec. 1914 H.M.S. Cordelia.
31 Dec. 1924 Plymouth.

No. 3597 **C. Frodsham.**
Purchased Aug. 1885 from the maker. No. 4, Annual trial 1885.

24 April 1890 Hong Kong. Page 1530
26 March 1891 H.M.S. Audacious.
9 Sept. 1897 H.M.S. Pheasant.
7 July 1899 H.M.S. Brilliant.
8 Feb. 1900 Hong Kong.
23 Feb. 1909 Malta.
6 March 1916 H.M.S. Hercules. Page 6426
16 Sept. 1919 H.M.S. Lowestoft.
17 June 1931 Portsmouth.

No. 5004 **C. Frodsham.**
(Belonged to the old Indian Navy).

14 May 1868 Portsmouth. Page 1283
22 June 1869 Bermuda Floating Dock.
12 Feb. 1874 Transit of Venus Observers.
13 April 1874 Capt. Tupman.
11 May 1874 Transit of Venus.
8 June 1876 H.M.S. Fawn.
28 May 1882 Hong Kong.
19 June 1891 H.M.S. Warspite.
5 March 1895 H.M.S. Sealark.
15 Nov. 1900 H.M.S. Pioneer.
6 Sept. 1922 Malta. Page 4124

No. 7004 **Frodsham.**
Purchased Dec. 1915 with Whaler. See Hyd. '17 Feb.

17 June 1919 Cape of Good Hope. Page 7353
28 Nov. 1919 Sold to U.S. Shipping Board.

No. 07462 **C. Frodsham.**
Deck Watch.
Purchased March 1890 from C. Frodsham and Co. No. 3 on trial. £18.

20 Dec. 1890 H.M.S. Northampton. Page 1662

17 April	1893	H.M.S. Tourmaline.
23 Aug.	1897	War Office.
28 Nov.	1899	Bermuda.
13 March	1903	H.M.S. Indefatigable.
31 Jan.	1906	H.M.S. Attentive.
14 Feb.	1910	H.M.S. Alert.
5 May	1910	H.M.S. Alert. Page 3726 Lost in "Niger". See Hyd. July 3 1916.

No. 07463 — **C. Frodsham. Deck Watch.** Purchased Feb. 1891 from C. Frodsham.

29 Dec.	1891	H.M.S. Linnet. Page 1731
6 July	1896	H.M.S. Thetis.
8 April	1897	H.M.S. Shelldrake.
21 May	1907	H.M.S. Illustrious. Lost from H.M.S. Illustrious.

No. 07586 — **C. Frodsham. Deck Watch.** Purchased March 1890 from C. Frodsham and Co. No. 4 on trial. £18.

12 Sept.	1894	Malta. Page 1663
8 Feb.	1900	Sydney.
17 Feb.	1905	H.M.S. Hermes.
24 Jan.	1906	H.M.S. Durham.
12 June	1912	Gibraltar.
12 Aug.	1916	R.F.A. Ferol.
14 Sept.	1916	H.M. Sub. G13.
14 May	1918	H.M.S. Lucia.
8 May	1923	H.M.S. Vulcan.
21 June	1926	Miss Belville.
22 June	1926	Sold to Miss Belville.

No. 07587 — **C. Frodsham. Deck Watch.** Purchased March 1890 from C. Frodsham and Co. No. 11 on trial.

29 May	1890	Torpedo Boat 62. Page 1664
23 Oct.	1892	H.M.S. Beagle.
2 March	1897	Colaba Observatory.
17 May	1898	H.M.S. Liffey.
18 Aug.	1918	Portsmouth. Transferred to Australian Government. (see letter August 24th 1921)
28 Nov.	1931	Replaced on books, see Hyd letter Nov. 28 1931. Page 10101
21 Jan.	1932	Malta.
17 Sept.	1934	Sold to J. James. See Hyd letter Sept. 19 1934.

No. 07953 — **C. Frodsham. Deck Watch.** Purchased Feb. 1891 from C. Frodsham.

13 Jan.	1892	H.M.S. Ringarooma. Page 1732
14 June	1897	H.M.S. Isis.
8 Sept.	1898	H.M.S. Proserpine.
8 Oct.	1901	Condemned by C. Frodsham. Labelled as placed in Museum.

No. 07958 — **C. Frodsham and Co. Deck Watch.** Purchased March 1893 from C. Frodsham and Co. £12·10.

28 Aug.	1894	Sydney. Page 1906
12 June	1899	Hong Kong.
10 June	1902	H.M.S. Scylla.
29 Nov.	1909	Gibraltar.
18 Jan.	1922	Portsmouth. Page 7493

No. 07959 — **C. Frodsham.** Purchased March 24th 1892 from C. Frodsham. £16.

13 Dec.	1895	H.M.S. Endymion. Page 1779
13 Jan.	1897	Cape of Good Hope. Lost overboard from H.M.S. St. George. See letter 18 Feb. 1898.

No. 08073 — **C. Frodsham and Co. Deck Watch.** Purchased March 1893 from C. Frodsham and Co. £16.

6 Dec.	1893	Bombay Observatory. Page 1884
7 July	1899	H.M.S. Vindictive.
11 June	1900	H.M.S. Haughty.
7 April	1903	H.M.S. Sunfish.
11 Sept.	1907	Malta.

30 May 1910 Antarctic Expedition.
28 Oct. 1914 Hong Kong.
15 Nov. 1920 Bombay.
28 July 1922 Disposals Board.
24 May 1923 Cut off books.

No. 08075 **C. Frodsham.**
Purchased March 24th 1892 from C. Frodsham. £15.
16 June 1898 H.M.S. Blenheim. Page 1791
14 March 1905 Torpedo Boat No. 88.
24 Feb. 1911 Gibraltar.
28 July 1922 Disposals Board.
24 May 1924 Cut off books.

No. 08093 **C. Frodsham and Co. Deck Watch.**
Purchased March 1893 from C. Frodsham. £12.
22 Sept. 1902 H.M.S. Urgent. Page 1892
7 June 1905 H.M.S. Cormorant.
12 June 1912 Gibraltar.
23 Nov. 1915 H.M.S. Dido.
1 May 1918 H.M.S. Silene. Page 8988
24 July 1918 Goole Ship Building Co. Job No. 222.
18 March 1919 Milford Haven.
28 July 1922 Disposal Board.

No. 09627 **Frodsham.**
Purchased July 1917 from C. Frodsham. £6 10s.
25 June 1918 H.M.S. Shark. Page 7511
Transferred to Australian Government.
Hyd. letter Aug. 24th 1921.

No. 09628 **C. Frodsham. Hack Watch.**
Purchased Nov. 1916 from C. Frodsham. £6 15s.
27 Nov. 1922 H.M.S. Greenwich. Page 7156
8 May 1930 H.M.S. Berwick.
14 Feb. 1935 H.M.S. Endeavour.
11 Sept. 1936 Wolfhound.

No. 09629 **C. Frodsham.**
Purchased June 1918 from C. Frodsham. £6 5s.
5 May 1919 N.S.O. Birkenhead. Page 8727
13 Sept. 1920 H.M.S. Canada.
Sold to Chilean Government.
Hyd. letter Dec. 23 1921.

No. 09631 **C. Frodsham. Hack Watch.**
Purchased Nov. 1916 from C. Frodsham. £6 15s.
11 July 1919 H.M.S. Myosotis. Page 7157
5 Jan. 1922 Hong Kong.
16 Nov. 1922 H.M.S. Iroquois.
7 Sept. 1927 Malta.
10 Oct. 1929 H.M.S. Effingham.
22 Jan. 1935 Hong Kong.

No. 10047 **C. Frodsham and Co. 2-Day.**
Purchased March 1903 from A.T. No. 11. £43.
16 Nov. 1911 Sheerness. Page 2851
Lost in "Hermes". See letter July 3. 1916.

No. 10049 **C. Frodsham and Co. 2-Day.**
Purchased March 1904 from C. Frodsham and Co. A.T. No. 25. £38.
3 March 1905 Hong Kong. Page 2973
9 Dec. 1910 Lieut. G. D. Spicer-Simson.
25 Nov. 1913 H.M.S. Merlin.
21 Feb. 1917 H.M.S. Riviera.
20 Sept. 1918 Harland and Wolff for job 500.
27 June 1928 Cape of Good Hope.
29 July 1936 Plymouth.

No. 10054 **C. Frodsham.**
Purchased April 1918.
Hyd. letter April 1918.
30 May 1918 Cape of Good Hope. Page 8778

20 Nov. 1923 Hong Kong.
30 July 1929 H.M.S. Endeavour.
25 Feb. 1936 Kullberg (Appro.).

No. 10064 **Frodsham.**
Purchased Dec. 1918 from C. Frodsham. £38.
16 Dec. 1918 C. Frodsham.
Page 9213
18 March 1918 M.S.S. Aphrodite.
Sold to United States. See Hyd letter Nov. 22 1914.

No. 108 **Parkinson & Frodsham.**
Purchased Aug. 16 1843.
2 Oct. 1843 H.M.S.V. Hydra.
Page 638
19 May 1845 H.M.S. Vulture.
12 June 1849 H.M.S. Castor.
6 July 1857 Transferred to Mr. F. Dent that he may make a money allowance for it, it being useless to the Government.
Bought by Mr. F. Dent for £2 and sanction for its sale given by the Admiralty 1857 August 13th.

No. 228 **Parkinson & Frodsham.**
7 May 1824 Hecla. Capt. Parry.
Page 245
2 May 1826 Beagle. Capt. P. Stokes.
29 June 1831 Talavera.
2 June 1837 Rhadamanthus.
23 Nov. 1840 Blazer.
1 Nov. 1841 Parkinson & Frodsham.
22 June 1886 Reported ruined.
26 June 1886 Taken off books.

No. 253 **Parkinson & Frodsham.**
28 May 1824 Snap. Page 246
14 May 1827 Hussar.
30 Sept. 1830 Etna.
5 July 1831 Prince Regent.
7 May 1836 Steamer Confidence.
11 June 1836 Hercules.
8 June 1837 Beagle.
1 June 1846 Ardent.
13 Aug. 1857 H.M.S. Black Eagle.
Page 796
8 Jan. 1860 H.M.S. Basilisk.
This chronometer as returned from the Basilisk is utterly ruined; it was lost in H.M.S. Jasner (gun boat) and remained some months under water before recovery.

No. 254 **Parkinson & Frodsham.**
7 May 1824 Fury. Capt. Hoppner.
Page 247
2 May 1826 Beagle. Capt. P. Stokes.
6 July 1831 Barham.
22 Dec. 1843 H.M.S.V. Cyclops.
10 Sept. 1847 Antelope.
10 May 1852 H.M.S. Herald.
15 Aug. 1861 Mr. J. Parsons, R.N.
7 April 1866 West Indian Survey.
2 Feb. 1881 Malta Dockyard.
17 Oct. 1883 H.M.S. Flirt. Page 1238
31 March 1884 Isaac (not worth repair).
26 June 1886 Taken off books.
23 Aug. 1887 Given with other chronometers to E. Dent & Co. in exchange for D. W. "Dent" 43109 and 43110.

No. 287 **Parkinson & Frodsham.**
20 Dec. 1823 Menai. Page 248
14 May 1827 Hussar.
16 June 1830 Alna.
13 May 1833 Hyacinith.
31 Jan. 1844 Bittern.
22 March 1850 H.M.S. Lady Franklin.
26 Jan. 1853 Resistance.
25 Nov. 1864 H.M.S Fox. Page 853
22 June 1867 H.M.S. Lee.
18 Dec. 1878 H.M.S. Fawn.
30 April 1880 H.M.S. Flying Fish.
3 March 1884 Hong Kong.
28 May 1910 H.M.S. Enchantress.
5 May 1910 Malta.
27 Nov. 1914 H.M.S. Laurentic.
Page 4093
12 May 1919 Lost in H.M.S. Politania

No. 423 **Parkinson & Frodsham.**
7 May 1824 Hecla. Capt. Parry.
Page 249

18 April	1826	Investigator. Mr. Geo. Thomas. Accounted for W. G. Thomas about 1827. No further trace. Considered lost.
No. 541		**Parkinson & Frodsham. Pocket.** From the Arctic Expedition. Uncertain as to its being the property of the Government.
16 Oct.	1854	Parkinson & Frodsham. Page 812
12 Oct.	1857	Mr. Dent (By order of Capt. Becker — Being Capt. Kellet's property)
No. 537		**Parkinson & Frodsham.** Purchased Sept. 1862 from Commander Mayne.
1 July	1867	H.M.S. Serapis. Page 1098
31 July	1884	Bombay Observatory.
5 Sept.	1888	Cape of Good Hope.
30 June	1890	H.M.S. Basilisk.
29 Oct.	1894	H.M.S. Victor Emanuel.
14 June	1898	Hong Kong.
18 Dec.	1900	Bombay. Page 2564
1 March	1920	Sold to Mr. A. N. Anderson.
No. 571		**Parkinson & Frodsham.** Purchased Sept. 1841.
27 May	1850	H.M.S. Prometheus. Page 535
19 April	1854	H.M.S. Majestic.
15 March	1856	H.M.S. Supply.
21 May	1870	H.M.S. Zebra.
25 July	1874	H.M.S. Bullfinch.
12 March	1885	H.M.S. Victor Emanuel.
30 April	1891	Cape Observatory. Page 1548
14 Nov.	1893	H.M.S. Widgeon.
30 March	1904	H.M.S. Audacious.
13 April	1905	H.M.S. Assistance.
3 March	1913	Malta.
2 July	1920	Messrs. Turnbull. Sold to Messrs. Turnbull.
No. 649		**Parkinson & Frodsham. Deck Watch.**
7 May	1824	Fury. Capt. Hoppner. Page 250
24 April	1826	Protector.
28 Nov.	1840	Locust.
19 June	1857	Fox. Expedition to the Arctic Regions.
29 Aug.	1860	Australian Coast Survey.
15 Dec.	1899	H.M.S. Rambler. Page 1456
26 Jan.	1916	H.M.S. Verbena. Page 6427
6 Dec.	1917	H.M.S. Hannibal.
28 Feb.	1918	H.M.S. Sandhurst.
28 July	1922	Disposals Board.
24 May	1923	Cut off books.
No. 699		**Parkinson & Frodsham. Pocket.**
24 March	1827	Hecla. Capt. Parry. Page 251
27 March	1828	Chanticleer. Capt. H. Foster.
22 Aug.	1831	Arnold & Dent.
1 Nov.	1832	Rhadamanthus.
22 April	1836	Fairy.
9 Jan.	1838	H.M.S. Hermes.
22 May	1841	Volage.
20 Sept.	1841	Styx.
26 July	1844	Longitude of Valentia.
28 Oct.	1844	Particular Service.
10 Sept.	1873	Major Wilson, R.E. (For Ashantee Experition). Page 1144
6 Oct.	1874	Sold to War Office. (See Ledger, P. 1362).
13 Oct.	1874	To the Controller Royal Arsenal, Woolwich (being the property of the War Office).
26 June	1886	Taken off books.
No. 701		**Parkinson & Frodsham. Pocket.**
24 March	1827	Hecla. Capt. Parry. Page 252
18 March	1829	River St. Lawrence.
11 Sept.	1833	Sea Flower.
20 Nov.	1833	Pantaloon.
9 March	1838	Modeste.
6 Jan.	1844	H.M.S.V. Pluto.

10 May	1848	H.M.S. Enterprise.
9 Jan.	1850	H.M.S. Investigator.
12 Oct.	1854	Arctic Expedition.
20 Dec.	1856	H.M.S. Satellite. Page 842
13 July	1861	H.M.S. Hecate.
27 Nov.	1872	H.M.S. Challenger.
28 Aug.	1878	H.M.S. Alert.
3 March	1885	H.M.S. Lark.
3 Oct.	1898	F .W. Dyson, Esq.
9 Jan.	1907	H.M.S. Sealark.
11 April	1913	Taken in exchange by Usher & Cole. Page 3913

No. 741 **Parkinson & Frodsham. Pocket.**

24 March	1827	Hecla. Capt. Parry. Page 253
18 March	1829	River St. Lawrence.
21 April	1836	Salamander.
2 Dec.	1837	Lightning.
20 March	1849	President. Page 414
16 July	1849	Capt. Beechy.
26 Sept.	1849	H.M.S. Jasper.
9 Jan.	1850	H.M.S. Investigator. Supposed lost in Arctic Regions in H.M.S. Investigator.

No. 750 **Parkinson & Frodsham. Pocket.**

25 Dec.	1831	Greenwich. Page 284
8 Feb.	1833	Secret Expedition.
9 April	1836	Mastiff.
4 April	1838	Tartarus.
26 July	1844	Mr. Sheepshanks at Kingstown. Longitude of Valentia.
5 June	1845	H.M.S. Vernon.
17 May	1849	H.M.S. Jasper.
30 March	1864	Mr. Pender. Page 1087
20 April	1874	Royal Naval College, Greenwich.
5 Jan.	1889	H.M. Surveying Vessel Paluma.
16 Jan.	1897	H.M.S. Egeria.
5 Oct.	1906	H.M.S. Euryalus.
28 Dec.	1906	Roberts. Sold to Mr. Roberts.

No. 773 **Parkinson & Frodsham.**

14 May	1845	Greenwich. Page 358 Exchanged for Parkinson & Frodsham 1228.

No. 799 **Parkinson & Frodsham.**

24 March	1827	Hecla. Capt. Parry. Page 254
27 March	1828	Chanticleer. Capt. H. Foster.
6 Oct.	1832	Hornet.
22 Sept.	1837	Fairy. Query, lost in the "Fairy".

No. 838 **Parkinson & Frodsham.** Purchased by Admiralty about Feb. 1833.

12 June	1833	Thunder. Page 285
22 Feb.	1845	Styx.
5 April	1857	H.M.S. Birkenhead.
4 Oct.	1859	H.M.S. Snake.
6 Dec.	1881	Basses Lighthouse Tender, Ceylon. Page 1439
18 Feb.	1892	H.M.S. Northampton.
17 April	1901	H.M.S. Mowhawk.
15 Dec.	1902	H.M.S. Landrail.
13 June	1906	H.M.S. Gossamer.
20 Dec.	1911	Hong Kong. Page 3860
7 Nov.	1918	H.M.S. Clio.
1 Sept.	1924	Sold to Messrs. Ray & Co. and F. Smith & Son Ltd.

No. 849 **Parkinson & Frodsham.** Purchased 1 July 1833.

12 July	1833	Southern Expedition. Page 321
14 Feb.	1834	Tribune.
28 April	1843	H.M.S. Herald.
3 Jan.	1844	Larne.
10 May	1848	H.M.S. Enterprise.
31 July	1850	H.M.S. Inflexible.
7 May	1852	H.M.S. Hermes.
13 June	1853	H.M.S. Nerbudda. Transferred from "Nerbudda" to "Hercules", and exchanged for new in 1855; no further trace.

No. 902 **Parkinson & Frodsham.**

27 March	1828	Chanticleer. Capt. H. Foster. Page 257

12 July	1832	Jupiter.
25 May	1836	Scylla.
30 Dec.	1847	H.M.S. Plover.
6 July	1858	H.M.S. Terrible. Page 1226
22 Jan.	1867	H.M.S. Charybdis.
18 June	1886	China.
16 Sept.	1889	Bombay Obs.
6 Aug.	1891	H.M.S. Buzzard.
20 Aug.	1896	H.M.S. Endymion.
6 Dec.	1899	H.M.S. Sheldrake.
24 Feb.	1902	H.M.S. Hearty.
27 Aug.	1906	E. Dent & Co. Taken in exchange by E. Dent & Co. for new Hack Watches. (See Hyd. letter 13 March 1907).

No. 925 **Parkinson & Frodsham**
Purchased 1921.
Late U.S.A. Mercantile. Page 9624

No. 948		**Parkinson & Frodsham. Pocket.**
24 March	1827	Hecla. Capt. Parry. Page 255
24 Nov.	1829	Undaunted.
21 Oct.	1834	Winchester.
22 Sept.	1838	Pluto.
28 Aug.	1840	Shearwater.
7 Sept.	1841	Ardent.
1 July	1846	Dido.
10 May	1848	H.M.S. Investigator.
22 June	1850	H.M. Surveying Vessel Asp.
15 Jan.	1864	H.M.S. Hecate. Page 843
18 April	1868	H.M.S. Bristol.
28 Aug.	1878	H.M.S. Alert.
14 Jan.	1884	H.M.S. Myrmidon.
30 Dec.	1896	H.M.S. Stork
17 Oct.	1906	Clockmakers Company.
7 Dec.	1906	Presented to the Clockmakers Company.

No. 980		**Parkinson & Frodsham Pocket.**
24 March	1827	H.M.S. Hecla. Capt. Parry. Page 256
9 Dec.	1828	Shannon.
19 Sept.	1833	Endymion.
23 May	1841	Spitfire.
8 April	1843	Blazer.
10 May	1845	Erebus. Lost in Erebus. Discovered amongst the relics of Sir John Franklyn by Capt. McClintock, 1859. See the voyage of the "Fox". Believed to be in the Museum of the United Services Institution.

No. 1042		**Parkinson & Frodsham. Pocket.**
13 Aug.	1831	Beagle. Capt. Fitzroy. Page 283
4 April	1837	Fairy.
24 Dec.	1838	Acheron.
23 June	1842	Philomel.
26 Dec.	1846	H.M.S. Albatross.
10 May	1852	H.M.S. Herald.
26 June	1862	H.M.S. Rapid. Page 1084
24 Oct.	1876	Capt. C. Warren, R.E.
17 Oct.	1882	T.O.V. Bermuda.
26 March	1884	H.M.S. Triton.
27 April	1892	J. Poole & Co.
5 July	1892	Not worth repair.
12 June	1902	H.M.S. Blake.
16 May	1906	H.M.S. Warspite. Page 2232
27 Aug.	1906	H.M.S. Euryalus. Taken in exchange by E. Dent & Co. for new Hack Watches.

No. 1095		**Parkinson & Frodsham.**
27 March	1828	Chanticleer. Capt. H. Foster. Page 258
2 Oct.	1832	Champion.
1 Jan.	1847	Cyclops.
15 April	1847	H.M.S.V. Gulnare.
21 April	1863	H.M.S. Jaseur.
25 May	1874	Transit of Venus. Page 1326
5 July	1875	Honolulu.
7 March	1879	Hong Kong, China.
24 June	1881	H.M.S. Victor Emanuel.
8 May	1883	H.M.S. Raven.
17 Dec.	1889	H.M.S. Goshawk.
12 Jan.	1894	H.M.S. Satellite.

15 Dec.	1894	H.M.S. Satellite. Page 2064
28 July	1896	Malta.
10 July	1899	H.M.S. Hawk.
21 Jan.	1902	H.M.S. Cockatrice.
1 July	1903	H.M.S. Edinburgh.
10 Feb.	1918	H.M.S. Challenger. Lost in H.M.S. Polanne. See letter May 12 1919.
No. 1204		**Parkinson & Frodsham.** Purchased by Admiralty about Feb. 1833.
19 May	1833	Fairy. Page 297
11 Nov.	1840	Transport Abercrombie Robinson.
23 Feb.	1852	H.M.S. Cormorant.
6 April	1867	H.M.S. Royalist. Page 832
14 March	1888	H.M.S. Britannia.
10 Dec.	1895	H.M.S. Sans Pareil.
9 April	1910	Sydney.
5 April	1916	H.M.S. Active. Page 4240
20 Sept.	1918	Gibraltar.
28 March	1919	H.M.S. Corsair.
6 Aug.	1919	Ex German S.S. Tannenberg.
20 Sept.	1919	Sold See Hyd. letter.
11 June	1920	Messrs. Price Canways. Returned. Hyd. letter Aug. 28th 1920.
18 Aug.	1920	Sold to Mr. Parker Wood. See Hyd. letter.
No. 1228		**Parkinson & Frodsham.** Given by the maker in exchange Parkinson 773. Page 360
17 Nov.	1836	Rhadamanthus.
5 Dec.	1837	Thunder.
19 Nov.	1839	Firefly.
27 Dec.	1842	Samarang.
25 March	1843	Blazer.
28 June	1845	Spitfire.
27 Oct.	1849	Volcano.
25 April	1850	H.M.S. Assistance.
2 Dec.	1856	H.M.S. Dee Page 834
15 Jan.	1864	H.M.S. Hecate.
4 May	1865	H.M.S. Serpent. Mislaid from "Serpent" 1865.
No. 1230		**Parkinson & Frodsham.**
9 Feb.	1833	Secret Expedition. Page 314
10 Jan.	1841	S.V. Pluto.
1 Aug.	1842	H.M. Surveying Vessel Columbia.
26 July	1844	Mr. Sheepshank's at Kingston for Longitude of Valentia.
19 March	1845	Rhadamanthus. Supplied to "Snap" 1848, for store at Ascension. No further trace.
8 May	1886	Written off.
No. 1285		**Parkinson & Frodsham.** Purchased. Hyd. letter April 1918. ex German Trawler Dr. Robitzah.
5 March	1918	Berry & Madsay. Page 8799
6 Feb.	1920	Sold to U.S. Shipping Board.
No. 1329		**Parkinson & Frodsham. Pocket.**
26 Dec.	1831	Greenwich. Page 298
19 July	1832	Beacon.
9 July	1836	Alban.
29 Sept.	1837	Rhadamanthus.
23 May	1841	Spitfire.
7 Jan.	1843	Acheron.
5 Feb.	1847	Rosamund.
2 Dec.	1856	H.M.S. Dee. Page 840
3 Aug.	1871	H.M. Surveying S Shearwater.
4 Oct.	1878	Major Gordon.
9 March	1880	Supply of Eastern Australia.
18 April	1883	H.M.S. Britannia.
29 May	1901	H.M.S. Waterwitch.
6 July	1903	Hong Kong.
Aug.	1911	Taken in exchange by E. Dent & Co. Page 3912
No. 1355		**Parkinson & Frodsham.** Purchased July 19, 1838
24 Aug.	1838	Gorgon. Page 422
6 July	1841	Salamander.
23 Dec.	1841	Driver.
10 Feb.	1848	Lucifer.

11 March	1863	H.M.S. Spiteful.
19 Sept.	1863	H.M.S. Scylla.
18 Oct.	1870	H.M.S. Juno.
24 Oct.	1871	Eclipse Expedition.
25 Feb.	1879	H.M.S. Druid.
25 April	1881	H.M.S. Firefly.
25 Oct.	1893	Cape of Good Hope. Page 1739
6 July	1896	H.M.S. Jaseur.
23 Feb.	1897	Sydney.
12 Oct.	1903	H.M.S. Duncan.
29 Aug.	1911	Usher & Cole. Taken in exchange by Usher & Cole.

No. 1454 **Parkinson & Frodsham. Pocket.**

31 Dec.	1826	Greenwich. Page 301
5 July	1832	Orestes.
4 Feb.	1845	Action.
4 March	1845	Dido.
2 June	1851	Megaera.
16 June	1870	H.M.S. Resistance. Page 1306
27 Sept.	1880	H.M.S. Carysfort.
27 Oct.	1882	Ark Royal, C.G. Hope.
23 Aug.	1887	Given with other chronometers to E. Dent & Co. in exchange for D. W. "Dent" 43109 & 43110. Having been converted into a Deck Watch on Dec. 30, 1878.

No. 1632 **Parkinson & Frodsham.** Purchased July 19 1838.

12 May	1843	Prince George Transport Page 423
24 April	1850	H.M.S. Resolute.
9 Sept.	1852	Cape Survey.
24 Nov.	1862	Admiral Washington.
3 June	1863	H.M.S. Royal Oak.
26 Sept.	1864	H.M.S. Supply.
6 July	1875	H.M.S. Beacon.
29 March	1876	H.M.S. Repulse.
Sept.	1884	Lost in the "Wasp".

No. 1701 **Parkinson & Frodsham.** Purchased July 19 1838.

10 Sept.	1838	Hercules. Page 419
2 Jan.	1840	H.M.S.V. Flamer.
25 March	1843	Blazer.
30 Sept.	1845	Blenheim.
12 Oct.	1852	Arctic Expedition.
4 Feb.	1862	H.M.S. Scourge.
30 Nov.	1866	Cape of Good Hope.
5 June	1874	H.M. Gunboat Foam.
27 Feb.	1891	H.M.S. Boomerang.
30 Dec.	1896	Sydney Page 2236
4 March	1902	H.M.S. Tamar.
14 July	1902	Hong Kong.
14 Sept.	1914	H.M.S. Benbow.
29 June	1915	H.M.S. Carnarvon.
1 March	1920	Sold to A. N. Anderson.

No. 1750 **Parkinson & Frodsham.**

Oct.	1834	Greenwich. Page 345
31 March	1835	Dublin.
20 July	1843	Crocodile.
2 Oct.	1843	H.M.S.V. Hydra.
19 Feb.	1848	Transport Nautilus.
13 Dec.	1859	T. Maclear for the Cape Observatory.
1 Nov.	1864	Sir Thomas Maclear, to replenish to Depôt at the Cape of Good Hope.
20 Aug.	1872	North American Boundary Commission. Page 1329
1 July	1886	H.M.S. Wye.
5 June	1894	H.M.S. Rodney.
14 Jan.	1898	H.M.S. Caesar.
10 May	1902	H.M.S Sutley.
20 Jan.	1916	H.M.S. Revenge. Page 3087
31 July	1928	Sold to Mr. W. Cardall.

No. 1770 **Parkinson & Frodsham.** Purchased on March 25th 1836.

26 April	1836	Swift. Page 364
31 July	1850	H.M.S. Inflexible.
22 June	1854	H.M.S. Wolverine.
4 Nov.	1863	H.M.S. Tamar.
18 Jan.	1878	H.M.S. Nassau. Page 1345
25 Nov.	1889	Isaac. Not worth repair.
15 June	1892	H.M.S. Dreadnought.
10 July	1899	H.M.S. Hawke.
17 Nov.	1899	H.M.S. Arethusa.
6 May	1903	H.M.S. Charybdis.
2 Oct.	1905	Usher & Cole. Taken in exchange by Messrs. Usher & Cole new chonometer.

No. 1826		**Parkinson & Frodsham.**
18 Nov.	1834	Vernon. Page 346
13 July	1841	Thunder.
6 Oct.	1841	Hecla.
9 Aug.	1842	Hydra.
19 Nov.	1842	Wasp.
24 May	1847	Royal Observatory for the use of the Alt. and Azimuth Instrument.
11 July	1859	H.M.S. Edgar Page 876
7 May	1863	H.M.S. Leander.
1 July	1867	H.M.S. Serapis.
7 April	1879	H.M.S. Tyne.
30 April	1880	H.M.S. Flying Fish.
15 Jan.	1886	H.M.S. Rambler.
14 Oct.	1889	H.M.S. Cruizer.
30 May	1899	H.M.S. Jupiter.
13 Sept.	1904	H.M.S. Landrail. Page 3075
17 April	1914	Bermuda.
4 Jan.	1918	H.M.S. Diligence.
3 Sept.	1918	H.M.S. Rentone.
16 April	1920	Sold to Messrs J. Lilley & Son.
No. 1886		**Parkinson & Frodsham. Pocket.** Purchased Aug. 7, 1845
24 Oct.	1845	Avon. Page 672 Reported by Capt. Denham as captured by the natives of Rio Ramus on April 6th, 1846.
No. 1887		**Parkinson & Frodsham. Pocket.**
1 July	1833	Greenwich. Page 322
4 Nov.	1833	Cruizer.
28 Oct.	1837	Lightning.
17 Aug.	1842	Alban.
25 May	1843	Blazer.
26 Nov.	1848	Sir A. Schombright.
10 Feb.	1857	H.M.S. Salamander.
26 March	1858	Oregon Expedition (Col. Hawkins).
17 Nov.	1866	H.M.S. Rifleman. Page 1112
9 Jan.	1871	To be used now as a "Deck Watch".
19 June	1888	H.M.S. Benbow.
20 Nov.	1894	Malta.
15 Jan.	1896	Sydney.
24 Oct.	1899	Sydney. Page 2636
29 Nov.	1909	Gibraltar.
10 Sept.	1915	H.M.S. Stag.
6 Dec.	1915	H.M.S. Arabis. Lost in H.M.S Arabis. See letter April 6th 1918.
No. 2061		**Parkinson & Frodsham.** Purchased July 19 1838.
27 July	1838	Colombine. Page 394
23 Nov.	1840	Blazer.
6 Jan.	1844	H.M.S.V. Pluto.
30 Dec.	1847	Stromboli.
25 Aug.	1852	H.M.S. Trident.
29 Nov.	1856	H.M.S. Waterloo.
30 April	1857	H.M.S. Hesper.
26 April	1866	Portsmouth. Lost in the "Hiphon".
No. 2077		**Parkinson & Frodsham.** Purchased Dec. 1835.
8 Dec.	1835	H.M.S.V. Sulphur. Page 253
15 Sept.	1847	Trafalgar.
10 Aug.	1861	Sydney for survey in in New South Wales. Page 754
29 June	1880	Queensland Survey.
14 Jan.	1884	H.M.S. Myrmidon.
11 May	1894	H.M.S. Acorn.
2 July	1900	H.M.S. Edinburgh.
8 Sept.	1916	H.M.S. Junior. Page 3902
1 March	1920	Sold to Mr. A. N. Anderson.
No. 2106		**Parkinson & Frodsham.** Purchased 1849 at New Zealand.
26 Sept.	1849	H.M.S. Inflexible. Page 762
10 Dec.	1852	H.M.S. Resistance.
12 Dec.	1853	H.M.S. Tyne.
18 Feb.	1856	H.M.S. Tartarus.
2 May	1866	H.M.S. Royalist.
28 June	1867	H.M.S. Nymph.
28 Nov.	1872	H.M.S. Bittern.
10 March	1885	Cape of Good Hope Observatory.
3 Dec.	1887	H.M.S. Alecto.
4 April	1892	Bombay.

5 Feb.	1897	H.M.S. Minerva. Page 2328
1 June	1922	Cape of Good Hope.
12 Feb.	1925	Sold to Mr. Noble.
No. 2111		**Parkinson & Frodsham.** Purchased by the Government Nov. 3 1837.
5 Dec.	1837	Thunder. Page 396
22 May	1841	Volage.
16 April	1845	Blazer.
15 Sept.	1847	Trafalgar.
14 Feb.	1848	H.M.S. Hecla.
5 June	1857	H.M.S. Rhadamanthus.
15 May	1861	H.M.S. Formidable.
3 Sept.	1861	H.M.S.Virago.
9 Nov.	1878	H.M.S. Seagull.
30 July	1879	H.M.S. Thunderer.
29 May	1894	H.M.S. Benbow.
2 Sept.	1904	H.M.S. Thrush.
11 Nov.	1912	H.M.S. Hindustan. Page 3336
22 Jan.	1916	H.M.S. Tiger.
28 March	1916	H.M.S. Euryalus.
27 April	1918	Hong Kong.
26 April	1937	Sold to Percy Webster, Esq.
No. 2146		**Parkinson & Frodsham.** Purchased Aug. 19 1848.
24 July	1856	H.M.S. Dee. Page 740 Lost in the "Camilla".
No. 2153		**Parkinson & Frodsham.** Purchased July 19 1838.
10 Sept.	1838	Sloop Rose. Page 397
14 Dec.	1842	H.MS.V. Megaera.
5 May	1846	Warspite.
1 May	1847	H.M.S. Apollo.
20 Nov.	1850	H.M.S. Lightning.
21 April	1863	H.M.S. Jaseur.
26 Nov.	1883	H.M.S. Victor Emanuel. Lost in H.M.S. Victoria.
No. 2154		**Parkinson & Frodsham.**
12 Sept.	1839	Terror. Page 470
31 Oct.	1848	H.M.S. Hector.
24 Oct.	1862	Missionary Yacht, Southern Cross. This chronometer was delivered to the Commander of "Nelson" by the mission on 1887 Feb. 16 and will be brought back to R.O.
2 May	1887	Returned.
6 June	1890	Prof. Thorpe.
25 July	1890	Prof. Rucker.
3 Sept.	1891	Bombay Observatory.
7 Feb.	1897	Victor Emanuel.
14 June	1898	Hong Kong.
1 Dec.	1899	Malta.
7 June	1904	H.M.S. Andromache. Page 3061
22 Sept.	1910	Plymouth. Transferred to Canadian Government. See letter 4th March 1911.
No. 2184		**Parkinson & Frodsham.**
12 Sept.	1839	Erebus. Page 472
3 May	1844	Java Transport.
3 Nov.	1847	Custer.
17 Sept.	1848	H.M.S. Dover.
7 Nov.	1850	H.M.S. Pluto.
14 Nov.	1855	H.M.S. Hesper.
7 June	1883	Naval Depot Sydney.
18 Dec.	1883	Hong Kong.
2 March	1888	H.M.S. Hearty.
1 Jan.	1895	Cape of Good Hope.
19 Sept.	1898	Malta Dockyard. Page 2326
30 July	1906	H.M.S. Swiftsure.
6 Dec.	1915	H.M.S. Arabis. Lost in H.M.S. Arabis. See letter 6th April 1918.
No. 2200		**Parkinson & Frodsham.** Purchased July 17 1839.
2 Oct.	1844	Eclair. Page 447
29 Feb.	1848	H.M.S. Star.
1 Dec.	1852	Rosamond.
3 Oct.	1853	Arab.
1 June	1857	H.M.S. Atter.
7 June	1858	H.M.S. Waterloo.
12 March	1864	H.M.S. Ranger.
12 Jan.	1875	H.M.S. Defence.
7 Aug.	1889	Sydney.
6 March	1891	H.M.S. Forester.
31 Aug.	1893	H.M.S. Widgeon. Page 1919
12 May	1898	H.M.S. Dido.
4 June	1903	Hong Kong.
11 Feb.	1915	H.M.S. Phaeton.
7 Aug.	1917	H.M.S. Candytuft.
22 May	1920	German S/S Pungo.
4 June	1920	Sold.

No. 2207 **Parkinson & Frodsham.**
Purchased July 17 1839.

28 Dec.	1839	Thunder. Page 445
23 Feb.	1850	H.M.S. Volage.
19 Nov.	1856	H.M.S. Waterloo.
13 Nov.	1862	H.M.S. Spitfire.
22 April	1872	H.M.S. Penelope.
14 Jan.	1884	H.M.S. Myrmidon.
9 Sept.	1889	Sydney.
13 Jan.	1890	H.M.S. Paluma.
30 Sept.	1897	Cape of Good Hope. Page 2104
6 March	1899	Bombay.
4 March	1902	H.M.S. Tamar.
29 Jan.	1914	Plymouth. Lost in " Majestic ". See letter July 3 1916.

No. 2211 **Parkinson & Frodsham. 2-day.**
Purchased July 17 1839.

26 March	1840	Pearl. Page 448
3 May	1845	Spy.
1 Aug.	1849	H.M.S. Persian.
24 March	1854	H.M.S. Alban.
26 Sept.	1856	H.M.S. Powerful.
16 March	1865	H.M.S. Alecto.
2 Feb.	1866	H.M.S. Favourite.
7 Nov.	1870	H.M.S. Thistle.
28 April	1886	H.M.S. Merlin.
27 April	1892	J. Poole & Co. not worth repair.
6 Nov.	1903	A. W. Webb. Page 2930
26 Nov.	1903	Hydrographer. Condemned as unfit for further service.
4 Dec.	1903	Cut off books.

No. 2216 **Parkinson & Frodsham.**

12 Sept.	1839	Erebus. Page 473
13 Nov.	1849	H.M.S. Enterprise.
31 July	1850	H.M.S. Inflexible.
14 Jan.	1856	H.M.S. Vesuvius.
	1866	Lost in the " Amazon ".

No. 2225 **Parkinson & Frodsham.**

12 Sept.	1839	Terror. Page 471
28 May	1859	H.M.S. Firebrand.
5 Dec.	1887	H.M.S. Terror.
22 Oct.	1895	Mercer.
9 Dec.	1895	H.M.S. Empress of India
13 Jan.	1903	H.M.S. Jupiter.
2 Feb.	1903	H.M.S. Royal Oak.
28 Dec.	1906	Roberts. Sold to Mr. Roberts.

No. 2264 **Parkinson & Frodsham.**
Purchased April 24 1840

23 Sept.	1840	Medea. Page 492
9 June	1847	H.M.S. Stern.
27 Sept.	1847	H.M.S. Havannah.
21 Nov.	1853	H.M.S. Rifleman.
12 Nov.	1857	H.M.S. Triton.
5 Oct.	1859	H.M.S. Reynard.
1 April	1870	H.M.S. Clio.
30 Aug.	1881	H.M.S. Sappho.
17 May	1886	H.M.S. Duncan.
13 Dec.	1886	HM.S. Lily. Lost in the " Lily ".

No. 2277 **Parkinson & Frodsham.**
Purchased Aug. 22 1840.

16 April	1843	N. American Boundary Line Expedition. Page 477
11 June	1857	H.M.S. Waterloo.
30 June	1862	H.M.S. Rosario.
22 May	1867	H.M.S. Aboukir.
10 March	1870	H.M.S. Fawn.
7 June	1883	Naval Depot Sydney.
17 Nov.	1892	H.M.S. Victor Emanuel.
18 Feb.	1896	H.M.S. Daphne.
8 June	1903	H.M.S. Exmouth.
14 Dec.	1911	Plymouth. Page 3229 Lost in " Pegasus ". See letter July 3rd 1916

No. 2291 **Parkinson & Frodsham.**
Purchased Aug. 1840

6 Oct.	1840	Transport Somersetshire Page 495
14 Sept.	1841	Transport Maria Soane.
3 Oct.	1846	Plover.
12 Oct.	1854	Arctic Expedition
11 Feb.	1857	H.M.S. Salamander.
4 Sept.	1861	H.M.S. Plover.
21 May	1867	Portsmouth. Exchanged for McCabe 521.

No. 2307 **Parkinson & Frodsham. Pocket.**
Purchased July 17 1839.

22 Aug.	1839	Steam V. Hecla. Page 449

25 March	1843	Blazer.
22 June	1852	H.M.S. Gossamer.
31 Oct.	1853	H.M.S. Scorpion.
17 April	1860	Capt. Washington R.N.
29 May	1860	Australian Coast Survey.
29 June	1881	H.M.S. Flying Fish.
16 Oct.	1888	Torpedo Boat No. 28
16 Jan.	1890	H.M.S. Penguin.
24 July	1893	H.M.S. Victor Emanuel.
25 Dec.	1897	H.M.S. Research.
28 July	1905	Eclipse Expedition.
27 Aug.	1906	E. Dent & Co. Taken in exchange by E. Dent & Co. for new Hack Watches.

No. 2308 **Parkinson & Frodsham. Pocket.**

Purchased July 17, 1839

17 Aug.	1839	Steam Vessel Phoenix. Page 450
25 March	1843	Blazer.
12 May	1849	Wanderer.
16 July	1849	Capt. Beechy.
23 March	1855	H.M.S. Phoenix.
25 Jan.	1856	H.M.S. Waterloo.
19 June	1856	Professor Smyth.
10 Nov.	1856	P. & F. to be adjusted to Mean Solar Time.
9 June	1857	Lieut. Blakiston (Royal Artillary).
	1857	Disposed of to Mr. Palliser. N. American Expedition.

No. 2310 **Parkinson & Frodsham. Pocket.**

Purchased Aug. 24, 1840

23 Sept.	1840	Medea. Page 563
5 July	1841	H.M.S.V. Confidence.
6 Oct.	1841	Thunder.
26 July	1844	Mr. Sheepshanks of Kingstown Longitude of Valentia.
2 Sept.	1848	H.M. Surveying Vessel, Thunder.
16 Jan.	1849	Sir W. Dennison, Survey of Van Diemen's Land. No record since issue to Tasmanian Government 1849.
	1876	Tasmanian Government say they have "no account of it".

No. 2311 **Parkinson & Frodsham. Pocket.**

Purchased July 19 1838.

3 Sept.	1838	Cutter Speedy. Page 420
9 Dec.	1844	H.M. Brig Skylark.
10 May	1845	Terror. Lost in the Terror.

No. 2313 **Parkinson & Frodsham. Pocket.**

Purchased Jan. 6 1842.

7 March	1842	Fly. Page 569
31 March	1847	H.M.S. Terrible.
6 Dec.	1847	Mr. A. Middleton.
16 July	1849	Capt. Beechy.
24 April	1850	H.M.S. Resolute.
12 Oct.	1854	Arctic Expedition.
18 Sept.	1855	H.M.S. Transport Urgent.
2 March	1858	Commander Beddingfield for Dr. Livingstone's Expedition to Southern Africa. Lost.

No. 2322 **Parkinson & Frodsham.**

Purchased July 17 1839.

27 Nov.	1844	Transport Princess Royal. Page 446
10 May	1845	H.M.S. Erebus. Lost in "Erebus".

No. 2324 **Parkinson & Frodsham.**

Purchased Sept. 1841.

13 Oct.	1841	Portsmouth. Page 540
10 May	1845	Terror. Lost in the "Terror".

No. 2335 **Parkinson & Frodsham.**

12 Sept.	1839	St. Helena and V. D. Land Observations. Page 468
10 April	1873	H.M.S. Nassau.
14 Jan.	1884	H.M.S. Myrmidon.
5 Sept.	1889	H.M.S. Australia.
21 March	1890	H.M.S. Victoria.
27 Sept.	1894	H.M.S. Bullfrog.
11 Jan.	1904	Malta.
30 May	1910	H.M.S. Gossamer.

23 Feb.	1915	H.M.S. Spanker. Page 3838
8 Nov.	1917	Malta.
18 Aug.	1920	Sold to Mr. F. Parker Wood.
No. 2336		**Parkinson & Frodsham.**
12 Sept.	1839	St. Helena and V. D. Land Observations. Page 469
13 Sept.	1843	Erebus.
13 Feb.	1844	Prince George Transport.
8 Nov.	1844	Thunder.
30 Jan.	1855	H.M.S. Tartar.
16 Dec.	1859	H.M.S. Monarch.
25 June	1861	H.M.S. Hornet.
20 April	1874	Royal Naval College, Greenwich.
28 April	1883	H.M.S. Himalaya.
15 Sept.	1886	H.M.S. Hearty.
3 May	1889	H.M.S. Research.
28 Aug.	1894	Sydney.
28 Nov.	1899	Bermuda.
20 Aug.	1902	H.M. Dockyard, Malta. Page 2919
4 Dec.	1903	H.M.S. Vindictive.
25 Oct.	1905	Northern Nigeria Survey.
25 Jan.	1909	Royal Observatory.
12 Feb.	1915	Malta.
18 Aug.	1920	Sold to Mr. F. Parker Wood.
No. 2357		**Parkinson & Frodsham. 8-day.** Purchased March 1864 from Capt. Parish.
10 March	1870	H.M.S. Aboukir. Page 1147
21 Feb.	1893	H.M.S. Elk. Page 1844
7 Sept.	1898	H.M.S. Cossack.
4 Sept.	1900	Sydney.
3 March	1903	Hong Kong.
12 April	1912	R.N. College, Dartmouth.
19 Aug.	1925	Sold to R. Webster, Ltd.
No. 2382		**Parkinson & Frodsham.** Purchased Jan. 6 1842.
7 March	1842	Fly. Page 576
11 Nov.	1850	H.M.S. Rattlesnake.
3 May	1851	H.M.S. Caradoc.
25 Feb.	1856	H.M.S. Rhadamanthus.
26 Sept.	1857	H.M.S. Dee.
22 July	1873	H.M.S. Beacon.
4 Jan.	1879	Sydney, Australia.
28 June	1882	Lieut. Gordon T.O.V.
6 Dec.	1884	H.M.S. Kingfisher.
6 Sept.	1895	Cape of Good Hope.
7 Nov.	1900	Bombay.
4 July	1902	H.M.S. Glassy.
6 Sept.	1906	H.M.S. Brilliant.
Aug.	1911	Taken in exchange by Usher & Cole. Page 3885
No. 2423		**Parkinson & Frodsham.** Purchased 1916 with S.S. Querida. £15. See Hyd. '17 Feb.
23 June	1919	Immingham. Page 7354
21 Nov.	1919	Sold to U.S. Shipping Board.
No. 2496		**Parkinson & Frodsham.** Purchased Aug. 15 1843.
2 Oct.	1843	H.M.S.V. Hydra. Page 635
21 June	1848	Blenheim Transport.
8 Feb.	1855	H.M.S. Melampson.
19 Nov.	1856	H.M.S. Waterloo.
17 Oct.	1862	H.M.S. Dromedary.
7 May	1863	H.M.S. Leander.
5 Feb.	1870	H.M.S. Danae
10 Oct.	1882	H.M.S. Linnet.
1 Sept.	1892	H.M.S. Victor Emanuel.
19 Jan.	1895	H.M.S. Orlando.
12 Nov.	1895	Colaba Observatory. Page 2230
12 June	1899	H.M.S. Endymion.
19 March	1913	Plymouth. Lost in H.M.S. Nottingham. See Hyd. letter April 6 1918.
No. 2523		**Parkinson & Frodsham.** Purchased Sept. 1841.
13 Oct.	1841	Portsmouth. Page 526
30 Oct.	1845	Juno.
28 July	1856	H.M.S. Brilliant.
7 July	1858	H.M.S. Waterloo
27 Nov.	1862	H.M.S. Flying Fish.

3 June	1863	H.M.S. Royal Oak.
11 Oct.	1869	H.M.S. Expoin.
5 Feb.	1870	H.M. Dockyard Bermuda.
24 July	1879	H.M.S. Research.
21 Sept.	1886	H.M.S. Pylades.
21 Feb.	1895	H.M.S. Scylla. Page 1960
12 May	1896	Prof. H. H. Turner.
15 Oct.	1900	Royal Naval College.
14 Jan.	1908	H.M.S. Cornwall.
27 Aug.	1929	H.M.S. Repulse.
26 April	1937	Sold to P. Webster.

No. 2524 **Parkinson & Frodsham.** Purchased Dec. 28 1841.

4 April	1848	H.M.S. Pluto. Page 564
3 Sept.	1855	HM.S. Vixen.
19 Feb.	1856	H.M.S. Medina.
18 March	1856	H.M.S. Supply.
15 Feb.	1867	Devonport. Sold by the India Government.

No. 2595 **Parkinson & Frodsham.** Purchased Aug. 26 1846.

1 Oct.	1847	H.M.S. Arab. Page 697
6 April	1852	H.M.S. Highflier.
2 Dec.	1856	H.M.S. Dee.
1 Jan.	1863	H.M.S. Rifleman.
24 July	1879	H.M.S. Research.
27 June	1882	H.M.S. Dart.
27 March	1888	H.M.S. Pylades.
24 June	1897	H.M.S. Tribune.
4 July	1901	H.M.S. Prometheus.
29 May	1902	Bombay.
9 Jan.	1908	H.M.S. Dwarf. Page 3055
16 March	1911	H.M.S. Shannon.
20 Feb.	1925	Sold to Mr. Noble.

No. 2614 **Parkinson & Frodsham.** Purchased Aug. 14 1828.

8 Nov.	1842	Thunder. Page 651
30 Sept.	1863	H.M.S. Hydra.
1 May	1866	H.M.S. Challenger.
27 May	1874	H.M.S. Raleigh.
17 Oct.	1882	T.O.V. Bermuda.
5 July	1888	H.M.S. Tartar.
4 Sept.	1900	Sydney Depot.
10 April	1908	Malta. Page 3360
11 April	1916	R.N.C. Dartmouth.

No. 2630 **Parkinson & Frodsham.** Purchased Aug. 7 1845.

24 Oct.	1845	Avon. Page 674
9 Feb.	1847	H.M.S. Amphion.
30 Jan.	1850	H.M.S.V. Hermes.
7 Nov.	1852	H.M.S. Snake.
28 April	1862	H.M.S. Adventure.
22 July	1873	H.M.S. Beacon.
4 Jan.	1879	Sydney, Australia.
6 March	1885	H.M.S. Tamar.
20 July	1892	H.M.S. Barracouta.
14 Feb.	1893	H.M.S. Hearty.
7 July	1899	H.M.S. Brilliant.
18 Jan.	1904	H.M.S. Gladiator. Page 3079
1 March	1920	Sold to Mr. A. N. Anderson.

No. 2661 **Parkinson & Frodsham.** Purchased Aug. 19 1848.

14 Feb.	1857	H.M.S. Vixen, to H.M.S. Herald. Page 751
16 July	1857	H.M.S. Waterloo.
5 Oct.	1857	H.M.S. Avon.
10 July	1860	H.M.S. Barracouta.
15 July	1865	H.M.S. Arethusa.
16 Jan.	1883	H.M.S. Stork.
29 Sept.	1885	H.M.S. Gannet.
14 Feb.	1890	H.M.S. Emerald.
20 Dec.	1893	Sydney.
10 June	1897	H.M.S. Wallaroo.
4 March	1904	H.M.S. Terpsichore. Page 3045
22 May	1920	ex German S/S Kybfels. Sold to Messrs. Macbeth and Co. See letter June 5th 1920.

No. 2709 **Parkinson & Frodsham. Pocket.**

12 Sept.	1839	Erebus. Page 474
26 July	1844	Mr. Sheepshanks at Kingstown Longitude of Valentia.
16 April	1845	Blazer.
28 July	1857	Capt. Washington.
22 April	1859	Sent to the Superintendent of Packets at Liverpool for conveyance to Dr. Baikie on the Niger.
19 Nov.	1861	Capt. Washington (returned from Africa).

8 Oct.	1862	H.M.S. Eclipse.
20 Aug.	1872	North American Boundary Commission.
7 Sept.	1887	Col. Home, R.E., C.B.
10 Jan.	1879	War Office.
7 Jan.	1890	H.M.S. Britannia.
6 April	1898	H.M.S. Triton.
27 Aug.	1906	E. Dent and Co. Page 2905 Taken in exchange by E. Dent and Co. for new Hack Watches. See letter March 13 1907.

No. 2791 **Parkinson & Frodsham.** Purchased Aug. 7 1845.

28 Nov.	1845	Transport Palinurus. Page 675
4 Jan.	1848	Hydra.
15 Feb.	1859	H.M.S. Waterloo.
17 April	1865	H.M.S. Mutine.
10 June	1870	H.M.S. Resistance.
21 Dec.	1880	H.M.S. Dotterel. Lost in the "Dotterel" 1881.

No. 2955 **Parkinson & Frodsham. Pocket** Purchased Aug. 7 1845.

24 Oct.	1845	Avon. Page 673
2 Oct.	1856	Lieut. R. Burton for the Bombay Army (Box left at the R. Obs.). No records since issued to Lieut. Burton for African Expedition about 1846.

No. 2958 **Parkinson & Frodsham. Pocket** Purchased Aug. 26 1846.

11 Nov.	1850	H.M.S. Rattlesnake. Page 698
24 April	1851	Prince Albert (Mr. Kennedy).
6 May	1853	H.M.S. Phoenix. Lost from "Phoenix" in Arctic Expedition 1854.

No. 3642 **Parkinson & Frodsham.** Received from Portsmouth 1874, Nov. 12; not known to be Government property. To be retained provisionally as a Government Chronometer.

4 Jan.	1881	H.M.S. Magpie. Page 1379
28 April	1886	H.M.S. Raven.
23 April	1897	Hong Kong.
3 Feb.	1919	Malta.
28 Jan.	1927	Malta. Page 9745
17 June	1931	Malta.
25 Jan.	1934	A. Johannsen. Sold to Prof. Freundlich. Istanbul Observatory Nov. 8 1935.

No. 3643 **Parkinson & Frodsham.** 2-Day. Purchased May 1860.

6 June	1860	Bulldog. Page 950
13 March	1865	H.M.S. Torch.
24 Aug.	1868	H.M.S Flora.
8 Oct.	1873	H.M.S. Nassau.
24 June	1881	H.M.S. Magpie.
14 Oct.	1882	T.O.V. Barbados.
6 Nov.	1883	Cape of Good Hope Observatory.
14 Oct.	1889	H.M.S. Scout.
31 Aug.	1893	H.M.S. Widgeon.
12 May	1898	H.M.S. Isis
19 April	1899	Malta.
31 Aug.	1900	H.M.S. Archer.
11 Sept.	1912	Sheerness. Page 3924 Lost in H.M.S. Russell. See Hyd. letter April 6 1918.

No. 3687 **Parkinson & Frodsham.** 2-Day Purchased May 1860.

25 Nov.	1864	H.M.S. Fox. Page 949
22 June	1867	H.M.S. Lee.
12 Feb.	1874	Transit of Venus Observers.
13 April	1874	Capt. Tupman.
24 April	1875	H.M.S. Wye.
2 July	1890	H.M.S. Bellerophon.

25 March	1893	H.M.S. Tourmaline.
7 Nov.	1894	Mr. Crommelin.
28 Feb.	1895	H.M.S. Barfleur.
11 Oct.	1898	H.M.S. Colossus.
19 May	1915	H.M.S. Bellona. Page 3557 Lost in H.M.S. Stonecrop. See Hydr. letter 12 May 1919.

No. 3688 **Parkinson & Frodsham.** Purchased Dec. 6 1860.

16 April	1861	Rear Admi. Codrington at Malta. Page 979
13 May	1869	H.M.S. Flora.
21 May	1881	H.M.S. Cockatrice.
11 Sept.	1890	H.M.S. Imogene.
23 Feb.	1892	Malta (H.M.S. Tyne).
23 Nov.	1892	H.M.S. Beagle
4 April	1898	H.M.S. Dolphin.
4 June	1903	Hong Kong.
19 May	1919	Plymouth.

No. 3697 **Parkinson & Frodsham.** Purchased Dec. 6 1860.

26 March	1861	Capt. Arlebar. Page 980
29 March	1875	H.M.S. Undaunted.
12 July	1880	H.M.S. Triumph.
12 April	1889	Malta.
19 June	1894	H.M.S. Northampton.
31 March	1898	Malta.
8 Aug.	1905	H.M.S. Thetis.
14 Feb.	1916	H.M.S. Achilles. Page 3928
8 Oct.	1919	Gibraltar.
6 Feb.	1920	Sold to U.S. Shipping Board.

No. 3704 **Parkinson & Frodsham.** Purchased March 1860.

23 May	1860	H.M.S. Wasp. Page 937
5 March	1867	H.M.S. Rodney.
15 Nov.	1886	Cape of Good Hope.
21 July	1892	H.M.S. Victor Emanuel.
15 Jan.	1897	H.M.S. Torch.
20 Jan.	1904	H.M.S. Clio.
5 Oct.	1906	Hong Kong.
28 Jan.	1909	H.M.S. Cameron.
24 Dec.	1935	Asprey and Co. Page 3922

No. 3705 **Parkinson & Frodsham.** Purchased Aug. 1861.

6 Jan.	1862	H.M.S. Rifleman. Page 1032
1 June	1889	H.M.S. Ruby.
20 Sept.	1894	H.M.S. Tartar.
12 June	1899	H.M.S. Endymion.
7 Jan.	1915	H.M.S. Cyclops.
11 Oct.	1915	M.S.A. Princess Alberta. Lost in H.M.S. "Princess Alberta".

No. 3719 **Parkinson & Frodsham.** Received in exchange for Porthouse 7231 (at the Cape Observatory in June 1863). See Capt. Evans's letter of Aug. 12th 1870.

26 Aug.	1882	T.O.V. Madagascar. Page 1310
3 Oct.	1885	H.M.S. Bacchanti.
17 April	1889	H.M.S. Hotspur.
23 Feb.	1892	H.M.S. Blake. Page 1737
16 Feb.	1898	Esquimalt.
23 Nov.	1899	H.M.S. Severn.
13 June	1904	Taken for use in Royal Observatory.
4 Jan.	1933	Mr. Maston for use in R.O.

No. 3943 **Parkinson & Frodsham.** Ex Prize SS Nicolas. Hyd. letter May 30 1917

28 Nov.	1916	S. W. Kellock and Co Page 7639
17 Dec.	1917	Hong Kong.
28 Oct.	1920	Gibralter.

No. 4099 **Parkinson & Frodsham.** Purchased March 1875.

27 Nov.	1891	Egeria. Page 1389
17 Nov.	1892	H.M.S. Victor Emanuel.
13 Jan.	1897	Cape of Good Hope.
30 March	1917	Bermuda.
5 Sept.	1917	H.M.S Victorian Page 7496 Transferred to the Australian Government. Hyd. letter Aug. 24th 1921.

No. 4283 **Parkinson & Frodsham.** 2-Day.
Purchased March 1900, from A.T. No. 33. £39.

10 Jan.	1901	Sydney. Page 2594
5 Dec.	1914	H.M.S. Devonshire.
25 Oct.	1919	H.MS. Flinders.
17 Sept.	1923	H.M.S. Veronica.
16 Feb.	1929	H.M.S. Malaya.
7 Aug.	1936	Portsmouth.

No. 4284 **Parkinson & Frodsham.** 2-Day.
Purchased March 1900 from A.T. No. 22. £41.

13 Feb.	1901	H.M.S. Terpsichore. Page 2595
8 March	1910	Sydney.
22 Dec.	1914	H.M.S. Devonshire.
9 Sept.	1915	H.M.S Hannibal.
6 Dec.	1919	Malta.
11 March	1926	Hong Kong.
25 Jan.	1928	H.M.S. Berwick.
8 May	1934	H.M.S. Grimsby.

No. 4436 **Parkinson & Frodsham. Pocket.**
Purchased April 1859.

13 Dec.	1860	Mr. Shortland surveying on the coast of Nova Scotia. Page 912
13 June	1866	H.M.S. Porcupine.
18 May	1870	H.M.S. Sylvia.
8 June	1886	Gibraltar.
5 Feb.	1889	H.M.S. Sylvia.
25 Feb.	1895	H.M.S Dart.
27 Aug.	1906	E. Dent & Co. Page 2703 Taken in exchange by Dent & Co. for New Hack Watches. See letter March 13 1907.

No. 4530 **Parkinson & Frodsham. Pocket.**
Purchased April 1859.

4 May	1864	H.M.S. Trafalgar. Page 909
31 July	1867	Navigating Lieut. C. H. C. Langdon.
24 Oct.	1870	Eclipse Expedition.
20 May	1874	Transit of Venus.
24 Oct.	1876	Capt. C. Warren, R.E.
10 Oct.	1884	Lent to War Office for use of army in Egypt.
31 May	1888	H.M.S. Stork.
9 Feb.	1898	New South Wales. Page 2106
11 July	1901	H.M.S. Dart.
27 Aug.	1906	Taken in exchange by E. Dent & Co. for new Hack Watches.

No. 4531 **Parkinson & Frodsham. Pocket.**
Purchased 19 Oct. 1865 from Parkinson and Frodsham.

15 Aug.	1866	H.M.S. Nassau. Page 1218
20 Aug.	1872	North American Boundary Commission.
24 Oct.	1876	Capt. C. Warren, R.E.
16 Dec.	1880	Sir Samuel Rowe.
13 Jan.	1882	H.M.S. Paluma.
2 Feb.	1899	H.M.S. Penguin.
11 March	1904	H.M.S. Egeria.
9 March	1914	Taken in exchange by E. Dent & Co. Page Page 3684

No. 5676 **Parkinson & Frodsham. Pocket.**
Purchased Feb. 7 1874.

14 May	1875	Arctic Expedition. Page 1363
9 Oct.	1879	H.M.S. Terror.
16 Nov.	1884	Sir C. Warren.
5 Jan.	1889	Surveying Vessel Dart.
27 Feb.	1893	H.M.S. Penguin.
8 Nov.	1895	H.M.S. Rambler.
17 Feb.	1903	H.M.S. Waterwitch.
18 April	1907	Hong Kong.
11 April	1913	Taken in exchange by Messrs. Usher & Cole. Page 3363

No. 5838 **Parkinson & Frodsham. Pocket.**
Purchased Feb. 7 1874.

14 May	1875	Arctic Expedition. Page 1364
15 May	1879	H.M.S. Sparrowhawk.
1 Aug.	1893	H.M.S. Dart.
6 Dec.	1906	HM.S. Waterwitch.
8 Sept.	1908	H.M.S. Egeria. Page 3464

15 Oct. 1915 Usher & Cole.
Exchanged for Hack Watches.

No. 7365 **Parkinson & Frodsham. Hack Watch.**
Purchased Oct. 1914 from maker. £5·15s.
2 Dec. 1914 H.M.S. Maidstone. Page 4532
Lost in H.M. Submarine E.10.
See Hyd. letter 27 Jan. 1917.

No. 7366 **Parkinson & Frodsham. Hack Watch.**
Purchased Sept. 1914 from maker. £5·5s.
17 Nov. 1914 H.M.S. Tyne. Page 4494
16 Aug. 1920 Sold to W. H. Johnson.

No. 7367 **Parkinson & Frodsham. Hack Watch.**
Purchased July 1914 from Parkinson and Frodsham. £5·5s.
31 March 1917 H.M.S. Dido. Page 4458
25 July 1917 Bombay.
17 April 1919 Hong Kong.
16 Aug. 1920 Sold to W. J. Johnson.

No. 7368 **Parkinson & Frodsham. Hack Watch.**
Purchased Oct. 1914 from maker. £5·10s.
3 Dec. 1914 H.M.S. Bonaventure. Page 4533
8 Oct. 1918 Immingham.
20 Jan. 1919 H.M.S. Steadfast.
7 Dec. 1928 S.M.S. Albury.
23 April 1930 Malta.
13 April 1933 Hong Kong.
28 May 1934 H.M.S. Sussex.

No. 7369 **Parkinson & Frodsham. Hack Watch.**
Purchased Sept. 1914 from maker. £5·10s.
24 Dec. 1914 Eng'. Capt. Gibbs, R.N. Page 4495
4 Feb. 1920 R.F.A. Sabo.
21 Jan. 1927 Malta.
24 June 1929 H.MS./M L 53.
14 Nov. 1930 R.F.A. Appleleaf.
19 May 1936 V. Kullberg.

No. 7370 **Parkinson & Frodsham. Hack Watch.**
Purchased March 1914 from Parkinson and Frodsham. £5.
5 March 1923 Gibraltar. Page 4318
23 April 1926 Malta.
22 Dec. 1931 H.M.S./M H 43.
24 Jan. 1934 Hong Kong.

No. 7371 **Parkinson & Frodsham. Hack Watch.**
Purchased Sept. 1914 from maker. £5·5s.
18 July 1916 Malta. Page 4496
11 April 1919 H.M.S. Kilgarvan.
2 March 1926 H.M.S. Caradoc.
29 June 1926 Malta.
5 Aug. 1927 H.M.S. Rodney.
Lost from H.M.S. Rodney. Hyd. letter Nov. 26th 1931.

No. 7372 **Parkinson & Frodsham. Hack Watch.**
Purchased Oct. 1914 from maker. £5·5s.
2 Dec. 1914 H.M.S. Maidstone. Page 4534
16 Feb. 1917 Usher & Cole.
In exchange for Usher & Cole H.W. No. 30143.

No. 7373 **Parkinson & Frodsham. Hack Watch.**
Purchased March 1914 from Parkinson & Frod-Frodsham. £5.
30 Dec. 1914 H.M.S. St. George. Page 4319
25 June 1918 Admiralty Station Dungeness.
11 Nov. 1918 Malta.
31 Dec. 1926 H.M.S. Revenge.
2 April 1928 H.M.S. Veronica.
19 Jan. 1934 R.F.A. Bacchus.

No. 7374 **Parkinson & Frodsham. Hack Watch.**
Purchased March 1914 from Parkinson & Frodsham. £5.
7 May 1914 Gibraltar. Page 4320
17 Feb. 1915 Hong Kong.
21 Dec. 1915 H.M.S. Leander.
Lost overboard H.M.S. Lively. Hyd. letter 20 Aug. 1918.

No. 7375 **Parkinson & Frodsham. Hack Watch.**
Purchased May 1914 from Parkinson & Frodsham. £5.5s.
25 Oct. 1915 H.M.S. Woolwich. Page 4420
6 Oct. 1916 Usher & Cole.
Exchanged for Usher & Cole H.W. No. 30139.

No. 7376 **Parkinson & Frodsham. Hack Watch.**
Purchased Dec. 1914 from maker. £5·15s.
30 Nov. 1915 H.M. Sub. E43
23 May 1917 Page 4592
7 Nov. 1917 H.M.S. Maidstone.
H.M.S. Sweetbriar.
16 Aug. 1920 Sold to W. J. Johnson.

No. 7391 **Parkinson & Frodsham. Hack Watch.**
Purchased Dec. 1914 from maker. £5 5s.
11 Jan. 1915 Lieut. V. Griffith, R.N.
13 Nov. 1917 Page 4589
Gibraltar.
17 Aug. 1920 Sold to W. J. Johnson.

No. 7393 **Parkinson & Frodsham.**
Purchased 1915 from P. and F.
13 April 1916 Grimsby Depot. Page 4806
15 April 1917 Immingham.
16 Aug. 1920 Sold to W. J. Johnson.

No. 7394 **Parkinson & Frodsham. Hack Watch.**
Purchased Jan. 1915, from maker. £5.10s.
9 Oct. 1915 H.M.S. St. Vincent. Page 4621
3 Dec. 1915 H.M. Sub. E 24.
10 March 1916 H.M.S. Avenger.
Lost in H.M.S. Avenger. Hyd. letter 12 May 1919.

No. 7395 **Parkinson & Frodsham. Hack Watch.**
Purchased Oct. 1914 from maker. £5·5s.
3 Dec. 1914 H.M.S. Bonaventure. Page 4535
24 June 1915 H.M.S. Hebe.
3 March 1916 Naval Base, Lowestoft.
29 July 1920 Bermuda.
4 Sept. 1926 H.M.S. Carysfort.
14 Jan. 1930 Malta.
27 Sept. 1935 R.F.A. Monterel.

No. 7396 **Parkinson & Frodsham. Hack Watch.**
Purchased Dec. 1914 from maker. £5·5s.
1 Dec. 1916 H.M.S. Alecto. Page 4590
7 May 1931 H.M.S. Emerald.
7 March 1935 H.M.S. Medea.

No. 7397 **Parkinson & Frodsham. Hack Watch.**
Purchased Dec. 1914 from maker. £5·10s.
20 Sept. 1918 Malta. Page 4591
22 Nov. 1918 H.M.S. Queen.
19 July 1926 Malta.
1 Jan. 1934 H.M.S. Nelson.
3 Sept. 1934 H.M.S. Alecto.
11 July 1936 Kullberg.

No. 7398 **Parkinson & Frodsham.**
Purchased 1915.
1 June 1915 Hong Kong. Page 4790
Lost in Transit from R.F.A. Mercedes.
Hyd. letter 22 March 1922.

No. 7399 **Parkinson & Frodsham. Hack Watch.**
Purchased Nov. 1915 from P. & F. £5·5s.

5 June	1918	H.M.S. Fearless. Page 6534
22 Nov.	1918	H.M.S. Usk.
19 July	1926	Malta.
6 Jan.	1933	Hong Kong.
24 July	1934	Malta.

No. 7400 **Parkinson & Frodsham.** Purchased 1915, from P. and F.

29 Jan.	1918	Dover Patrol. Page 4791
6 Sept.	1918	Immingham.
22 Sept.	1927	H.M.S. Curacoa.
19 Oct.	1927	Cape of Good Hope.
29 Jan.	1934	Hong Kong.
30 April	1936	Kunzler.

No. 7401 **Parkinson & Frodsham.** Purchased from P. & F. 1915.

22 May	1915	H.M.S Dahlia Page 4783 Lost from the "Dahlia". See Hyd. letter 23 Nov. 1915.

No. 7402 **Parkinson & Frodsham. Hack Watch.** Purchased Jan. 1915 from maker. £5·5s.

7 Aug.	1915	H.M.S. Woolwich. Page 4637
17 May	1916	H.M.S. Tigress.
26 Aug.	1916	H.M.S. Laburnum.
16 Aug.	1920	Sold to W. J. Johnson.

No. 7403 **Parkinson & Frodsham. Hack Watch.** Purchased Jan. 1915 from maker. £5·10s.

6 March	1915	H.M.S. Penelope. Page 4622
25 June	1915	H.M.S. M30.
14 Dec.	1916	Malta.
12 March	1926	Gibraltar.
2 Jan.	1936	Hong Kong.
24 Sept.	1936	H.M.S. Hunter.
29 Dec.	1936	Malta.

No. 7404 **Parkinson & Frodsham. Hack Watch.** Purchased Jan. 1915 from maker. £5·10s.

9 March	1915	Gibraltar. Page 4623
16 Aug.	1920	Sold to W. J. Johnson.

No. 7405 **Parkinson & Frodsham** Purchased 1915 from maker.

30 Nov.	1915	H.M.S. Dido. Page 4780
13 Dec.	1916	H.M.S. Vulcan.
12 Dec.	1918	H.M.S. Maidstone.
11 July	1919	H.M.S. Quadrille.
26 June	1934	H.M.S. Rochester.
18 Nov.	1935	Cape of Good Hope.
19 Oct.	1936	H.M. S/m L27.

No. 7406 **Parkinson & Frodsham Hack Watch.** Purchased Jan. 1915 from maker. £5·5s.

17 May	1915	H.M.S. Bellona. Page 4638
12 Aug.	1915	Hong Kong.
15 Sept.	1917	H.M.S. Hecla. Stolen from H.M.S. Beagle. Hyd. letter 9 May 1918.

No. 7407 **Parkinson & Frodsham Hack Watch.** Purchased Jan. 1915 from maker. £5·5s.

20 May	1915	H.M.S. Stonewall Jackson Page 4639
20 Jan.	1918	Immingham.
5 Sept.	1918	H.M.S. Orwell.
12 March	1926	Gibraltar.
17 April	1930	H.MS. Effingham.
15 April	1936	Gibraltar.

No. 7408 **Parkinson & Frodsham**

25 Aug.	1916	H.M.S. Sandhurst. Page 4781
24 June	1918	O. in C. Oak Lodge, Dumpton Gap
20 Sept.	1918	H.M.S. Pelargonium.
11 Dec.	1926	H.M.S. Warwick
18 April	1929	Hong Kong.
16 Jan.	1931	H.M. S/m L22.
4 May	1931	Hong Kong.
3 Sept.	1936	H.M.S. Hostile. Page 10135

No. 7409 **Parkinson & Frodsham**

10 Aug. 1915 H.M.S. Laburnum. Page 4782
9 Nov. 1916 Hong Kong.
2 March 1926 H.M.S./m XI.
3 Dec. 1928 H.M.S. Campbell.
31 Dec. 1935 Kullberg.

No. 7410 **Parkinson & Frodsham** Purchased 1915 from P. & F.

5 June 1915 H.M. Trawler Sparrow. Page 4792
24 Oct. 1916 Immingham.
10 Jan. 1917 Gibraltar.
24 Feb. 1919 Malta.
16 Aug. 1920 Sold to W. J. Johnson.

No. 7411 **Parkinson & Frodsham** Purchased 1915 from P. & F.

19 April 1916 Malta. Page 4797
30 June 1916 H.M.S. Alecto.
18 Sept. 1917 Malta. Transferred to Air Ministry. Hyd. letter Feb. 2 1924.

No. 7412 **Parkinson & Frodsham Hack Watch** Purchased Jan. 1915 from maker. £5·10s.

27 March 1915 H.M.S. Cyclops. Page 4640
29 March 1916 Edinburgh.
27 May 1916 H.M.S. Diligence.
5 May 1919 H.M.S. Woolwich.
26 Aug. 1920 Sold to W. J. Johnson.

No. 7413 **Parkinson & Frodsham Hack Watch.** Purchased Aug. 1915 from P. & F. £5·10s.

25 March 1916 H.M.S. Genista. Page 5334
Lost in H.M.S. Genista. See Hyd. letter April 6th 1918.

No. 7415 **Parkinson & Frodsham Hack Watch.** Purchased Aug. 1915 from P. & F. £5·5s.

21 Sept. 1915 Malta. Page 5329
7 Feb. 1917 Immingham.
16 Aug. 1920 Sold to W. J. Johnson.

No. 7417 **Parkinson & Frodsham** Purchased 1915 from P. & F.

22 July 1915 H.M.S. Hebe. Page 4798
5 March 1916 H.M.S. Crescent.
25 Feb. 1926 Hong Kong.
30 Nov. 1928 H.M.S. Colne.
12 Feb. 1931 Bermuda.
24 Jan. 1936 H.M.S. Sardonyx. Page 10227
30 Oct. 1936 Kullberg.

No. 7418 **Parkinson & Frodsham** Purchased 1915 from P. & F.

24 May 1915 C/o No. 12 Special Service Squadron. Page 4786
27 Sept. 1915 H.M.S. Cevic.
22 April 1916 H.M.S. Titania. Lost in H.M.S. Contest. Hyd. letter 12 May 1919.

No. 7419 **Parkinson & Frodsham** Purchased 1915 from P. & F.

24 July 1918 H.M.S. Lucia. Page 4784
16 Nov. 1918 Queens Dock, Hull for Job 406.
16 April 1919 Immingham.
17 April 1926 H.M.S. Stalk.
3 May 1929 H.MS. Rosemary.
6 Dec. 1933 H.M.S. Skate.

No. 7420 **Parkinson & Frodsham** Purchased 1915 from P. & F.

3 Dec. 1915 H.M. Sub. V3. Page 4805
17 Sept. 1917 H.M.S. Alecto.
6 July 1918 H.M.S. Hecla.
11 June 1926 Hong Kong.
20 Nov. 1929 H.M. S/m R4.
28 April 1930 H.M.S. York.
15 July 1931 H.M.S. Walpole.
15 Sept. 1934 R.F.A. British Lantern.

No. 7421 **Parkinson & Frodsham Hack Watch.**
Purchased Aug. 1915 from P. & F. £5·10s.

21 Sept.	1915	Malta. Page 5330
27 Dec.	1916	H.M.S. Phoebe.
17 Feb.	1917	H.M.S. Woolwich.
31 Aug.	1917	H.M.S. Oriole.
13 Oct.	1917	H.M.S. Verdun.
28 Dec.	1918	H.M.S. Woolwich.
14 July	1936	Malta.

No. 7422 **Parkinson & Frodsham**
Purchased 1915 from P. & F.

7 March	1919	Immingham. Page 4794
24 July	1933	Malta.
24 Sept.	1935	Port Said.
29 Dec.	1936	Malta.

No. 7423 **Parkinson & Frodsham Hack Watch.**
Purchased Sept. 1915 from P. & F. £5·10s.

13 Oct.	1915	Malta. Page 5331
2 Aug.	1918	H.M.S. Dido.
11 Oct.	1921	Chatham N.S.O.
25 March	1927	Malta.
24 Jan.	1929	H.M.S. Warspite.
27 April	1931	Bombay.
6 July	1932	H.M.S. Osmonde.
1 Jan.	1934	Malta. Page 10143

No. 7424 **Parkinson & Frodsham**
Purchased 1915 from P. & F.

10 Aug.	1915	H.M.S. King George V. Page 4807
10 Oct.	1916	Sydney. Supplied to Australian Commonwealth. See Hyd. 25 Oct. 1916.

No. 7425 **Parkinson & Frodsham**
Purchased 1915 from P. & F.

12 Aug.	1915	Hong Kong. Page 4795
1 July	1916	H.M. Sub. J4.
13 May	1931	H.M.S. Hood.
17 Nov.	1936	Kullberg.

No. 7429 **Parkinson & Frodsham**
Purchased 1915 from P. & F.

26 July	1915	H.M.S. Lavender. Page 4799 Lost in H.M.S. Lavender. Hyd. letter 12 May 1919.

No. 7431 **Parkinson & Frodsham**
Purchased 1915 from P. & F.

22 July	1915	H.M.S. River Fisher. Lost from S.S. River Fisher. Page 4800 See Hyd. letter 26 April 1917.

No. 7433 **Parkinson & Frodsham**
Purchased 1915 from P. & F.

7 April	1917	Malta. Page 4787
18 Sept.	1917	Gibraltar.
9 May	1918	Ad. Transpt. Office.
11 March	1926	H.M.S. Heliotrope.
25 March	1927	Malta.
16 June	1936	Hong Kong.

No. 7434 **Parkinson & Frodsham**
Purchased 1915 from P. & F.

24 May	1915	Portsmouth. Page 4788 Lost in H.M.S. Lord Salisbury. Hyd. letter 12th May, 1919.

No. 7435 **Parkinson & Frodsham**
Purchased 1915 from P. & F.

28 July	1915	H.M.S. Viceroy. Page 4801
30 May	1916	H.M. Sub. G.8.
24 Oct.	1916	Capt. (S) River Tees.
23 Feb.	1917	Malta.
5 Sept.	1918	Bermuda.
10 April	1933	H.M.S. Eagle.
4 July	1934	Hong Kong.
24 May	1935	H.M.S. Firedrake.
2 Oct.	1936	H.M.S. Westcott.

No. 7436 **Parkinson & Frodsham**
Purchased 1915 from P. & F.

10 Aug.	1915	H.M. Sub. E29. Page 4808

16 Aug. 1920 Sold to W. J. Johnson.

No. 7437 **Parkinson & Frodsham**
Purchased 1915 from P. & F.
23 July 1915 Tug Slieve Foy. Page 4802
15 April 1926 H.M.S. Hood.
4 Aug. 1928 H.M.S. Centurian.
24 April 1931 Bombay.
19 Jan. 1934 H.M.S. Barham.
24 Sept. 1935 Port Said.

No. 7438 **Parkinson & Frodsham**
Purchased 1915 from P. & F.
25 Oct. 1915 H.M.S. Aurora. Page 4809
30 Jan. 1918 Immingham.
Stolen from H.M.S. Benbow.
Hyd. letter 25th July, 1921.

No. 7440 **Parkinson & Frodsham Hack Watch.**
Purchased Aug. 1915 from P. & F. £5.5s.
21 Sept. 1915 R.F.A. Olympia. Page 5335
10 March 1916 Messrs. Vickers, Ltd.
7 July 1916 H.M.S. Birmingham.
26 Aug. 1920 India Office.
Sold to India Office.
Hyd. letter Feb. 4th, 1921.

No. 7441 **Parkinson & Frodsham Hack Watch.**
Purchased Sept. 1915 from P. & F. £5 5s.
13 Oct. 1915 Malta. Page 5332
18 May 1916 Sydney.
Transferred to Australian Government.
Hyd. letter 24th Aug. 1921.

No. 7442 **Parkinson & Frodsham Hack Watch.**
Purchased Sept. 1915 from P. & F. £5 5s.
18 Sept. 1917 Malta. Page 5333

26 Nov. 1934 H.M.S. Nelson.

No. 7443 **Parkinson & Frodsham**
Purchased 1915 from P. & F.
26 May 1915 Sheerness. Page 4785
Lost in H.M.S. Tervani.
See Hyd. letter 6 April, 1918.

No. 7444 **Parkinson & Frodsham**
Purchased 1915 from P. & F.
10 June 1915 Admiralty Officer, Folkestone. Page 4789
11 Feb. 1920 Malta.
12 March 1926 Gibraltar.
26 Aug. 1927 H.M.S. Furious.
22 Oct. 1928 H.M.S. Rowena.
3 July 1934 H.M.S. Sable.
6 Oct. 1936 H.M.S Vidette

No. 7446 **Parkinson & Frodsham**
Purchased 1915 from P. & F.
11 Aug. 1915 H.M.S. M28. Page 4810
22 July 1916 H.M.S. Lucia.
24 Oct. 1916 Capt. (S) River Tees.
16 Aug. 1934 H.M.S. Revenge.
6 Feb. 1935 Malta.
9 Jan. 1936 H.M.S. Gloworm.

No. 7447 **Parkinson & Frodsham**
Purchased 1915 from P. & F.
29 July 1915 H.M.S. Woolwich. Page 4796
25 Aug. 1915 H.M.S. Phoenix.
25 Oct. 1915 H.M.S. Mystic.
13 May 1916 H.M.S. Blake.
28 Sept. 1916 H.M.S. Titania.
16 Jan. 1924 H.M.S. Sardonyx.
8 Aug. 1926 Kullberg

No. 7448 **Parkinson & Frodsham**
Purchased 1915 from P. & F.
29 April 1918 H.M.S. Phoebe.
16 Aug. 1920 Page 4793
Sold to W. J. Johnson.

No. 681 **Baker.**
25 Nov. 1828 Challenger. Page 131

6 Sept.	1834	Columbia.
19 May	1845	H.M.S. Vulture.
23 March	1852	H.M.S. Assistance.
23 Oct.	1852	Frodsham & Baker.
30 Jan.	1860	Frodsham & Baker. Page 930
1 Oct.	1861	H.M.S. Archer.
20 April	1863	Frodsham & Baker.
6 March	1865	G. E. Frodsham.
11 Nov.	1867	HM.S. Myrmidon.
12 Nov.	1875	H.M.S. Juno.
26 Aug.	1886	H.M.S. Tourmaline.
14 Jan.	1896	H.M.S. Theseus. Page 1695
18 March	1909	H.M.S. Carnarvon.
Aug.	1911	Taken in exchange by Usher & Cole.

No. 864 **Baker.**

1 Oct.	1831	Greenwich. Page 293
2 Jan.	1832	Polaris.
23 Dec.	1837	H.M.S. Hermes.
10 April	1838	Mastiff.
12 Jan.	1848	Royalist.
24 July	1854	Frodsham & Baker.
20 March	1855	H.M.S. Firefly.
22 May	1861	H.M.S. Ranger.
21 Dec.	1863	Frodsham & Baker.
18 Jan.	1864	Frodsham & Baker.
13 Feb.	1871	H.M.S. Megaera. Page 1163
7 April	1879	H.M.S. Tyne.
23 Aug.	1887	Given with other Chronometers to E. Dent & Co. in exchange for D.W's, Dent 43109 and 43110.

No. 986 **Baker.**

		Purchased from trial.
Feb.	1835	Greenwich. Page 349
7 Jan.	1856	Frodsham & Baker.
13 Sept.	1883	H.M.S. Orontes.
19 May	1886	G. E. Frodsham.
27 Sept.	1886	H.M.S. Britannia. Page 1547
12 May	1896	Professor H. H. Turner.
22 Nov.	1897	H.M.S. Rodney.
8 Jan.	1904	Malta.
11 July	1915	HM.S. "M. 21".
17 Feb.	1920	A. N. Anderson. Sold to A. N. Anderson.

No. 1014 **Baker**

		Purchased July 19, 1838
22 Aug.	1842	H.M.S. Daphne. Page 428
7 Oct.	1847	H.M.S. Blazer.
10 May	1852	H.M.S. Herald.
10 June	1861	Frodsham & Baker.
21 Nov.	1861	H.M.S Industry.
21 Sept.	1863	Frodsham & Baker.
30 April	1864	H.M.S. Bombay. Lost in the "Bombay".

No. 6068 **Frodsham & Baker.**

18 Feb.	1856	Purchased 1855. Turkish Government steamer Balbee. Page 817
Nov.	1875	Hydrographer reports this Chronometer not being the property of the Government. See letter Dec. 1, 1875.

No. 6149 **Frodsham & Baker.**

		Purchased Sept. 1859.
5 Dec.	1859	T. Maclear, Esq., to replenish Depot at the Cape of Good Hope. Page 922
20 June	1867	H.M.S. Gannet.
11 May	1874	Transit of Venus.
3 Dec.	1878	Cape Observatory.
27 April	1882	Transit of Venus.
1 Feb.	1883	T.O.V. Jamaica.
24 June	1885	H.M.S. Bacchanti.
14 Feb.	1905	Cape of Good Hope.
10 Aug.	1916	Bombay. Page 3202
6 Feb.	1920	Sold to U.S. Shipping Board.

No. 6160 **Frodsham & Baker.**

		Purchased Dec. 6, 1860.
27 March	1861	Malta. Page 998
12 July	1869	G. E. Frodsham.
23 May	1870	H.M.S. Racoon.
10 April	1877	H.M.S. Argus.
8 Aug.	1878	Royal Naval Yard Deptford.
18 Dec.	1884	Hong Kong.
7 Dec.	1885	G. E. Frodsham. Returned as not worth repair.
26 June	1886	Cut Off Books.

23 Aug.	1887	Given with other chronometers to E. Dent & Co. in exchange for D. W. 'Dent' 43109 and 43110.
No. 6188		**Frodsham & Baker.** Purchased Sept. 1859.
15 Oct.	1864	H.M.S. Achilles. Page 918
15 Sept.	1869	H.M.S. Cossack.
11 May	1874	Transit of Venus.
5 May	1882	H.M.S. Triton.
19 Nov.	1887	Isaac. Sold to Mr. Isaac for £4.
No. 6203		**Frodsham & Baker.** Purchased Dec. 6, 1860.
27 March	1861	Malta. Page 997
21 Aug.	1863	H.M.S. Recruit.
27 July	1868	G. E. Frodsham.
29 Aug.	1873	H.M.S. Duncan.
10 April	1877	H.M.S. Argus.
5 April	1881	Prince Edward Island Survey.
6 Dec.	1884	H.M.S. Kingfisher.
16 Oct.	1894	H.M.S. Seamew.
17 July	1905	For use in Heliographic Department.
2 Oct.	1905	Usher & Cole. Taken in exchange by Messrs. Usher & Cole for new chronometer watches.
No. 7163		**Frodsham & Baker.** Purchased from trial 1858.
13 Sept.	1858	Altered to Sidereal Time. Page 890
25 Oct.	1858	Col. Moody Expedition to British Columbia. Col. Moody paid for.
No. 7851		**Frodsham & Baker. Pocket.** Purchased April 1859.
27 July	1859	Mr. Skead (Adm. Surveyor) Cape of Good Hope. Page 911.
12 Dec.	1874	H.M.S. Basilisk.
15 May	1878	H.M.S Fawn
23 Sept.	1886	Torpedo Boat No. 22.
12 Nov.	1887	H.M.S. Myrmidon.
13 Jan.	1891	H.M.S. Paluma.
7 Nov.	1894	H.M. Hull.
14 March	1897	Crown Agents for Colonies.
16 Sept.	1902	H.M.S. Goldfinch. Page 2936
26 Sept.	1909	H.M.S. Mutine.
15 Oct.	1915	Usher & Cole. Exchange for Hack Watches.
No. 3/3308		**C. M. Frodsham.** Purchased Sept. 1865 from C. M. Frodsham.
25 July	1866	H.M.S. Antelope. Page 1212
23 Sept.	1874	Transit of Venus.
9 May	1889	H.M.S. Daphne.
24 July	1893	H.M.S. Victor Emanuel.
19 Feb.	1894	Sydney.
9 March	1916	H.M.S. Southampton. Page 3683
18 Aug.	1921	Huntsgreen Transport.
1 June	1922	Escombe McGath & Co.
23 Aug.	1926	Hong Kong.
No. 4/3348		**C. M. Frodsham.** Purchased Sept. 1864 from the maker.
14 Jan.	1871	H.M.S. Torch. Page 1158
29 April	1887	H.M.S. Wasp.
Sept.	1887	Lost in "Wasp".

No. 1 **H. Frodsham.**

13 Aug. 1831 Beagle. Capt. Fitzroy. Page 281

The Chronometer H. Frodsham I, was left with the Peruvian Government, when the Beagle was out on that coast surveying (see Capt. Becker's letter to the Astronomer Royal 1857, May 14).

There is another H. Frodsham I (see Page 1107) which first came to the Observatory by purchase from Adm. Dundas in 1862.

Taken off books 1886 June 26.

No. 1 **H. Frodsham.**

Purchased Nov. 1862 from Adm. Dundas. (There was another H. Frodsham I, see Page 281 which was left with the Peruvian Govt. before 1857.

11 April 1871 H.M.S. Scout. Page 1107

7 June 1883 Naval Depot, Sydney.

22 July 1895 H.M.S. Landrail.

9 April 1896 H.M.S. Magpie.

25 Feb. 1904 H.M.S. Flora. Page 2637

29 April 1904 A. W. Webb.

24 May 1904 Destroyed by order of the Hydrographer.

No. 2100 **H. Frodsham.**

Purchased Nov. 1916 from J. Lilley & Son. £28.

17 Feb. 1917 H.M.S. Blanche. Page 7175

6 Feb. 1920 Sold to U.S. Shipping Board.

No. 3847 **Frodsham & Keen.**

Purchased April 1916 ex H.M.S. Tyrolia.

18 April 1916 S.D. Neill. Page 6879

7 Oct. 1916 H.M.S. Glorious

31 May 1919 H.M.S. Silvia.

5 Jan. 1922 Malta.

22 April 1927 R.F.A. War Bahadua.

17 July 1931 Gibraltar.

No. 3853 **Frodsham & Keen.**

Purchased, see Hyd. letter March 7 1916 from "Ruthenia".

5 Feb. 1916 Kelvin, Bottomly and Baird. Page 5428

16 May 1919 H.M.S. Humber.

Sold to Messrs. Kelvin,

11 Dec. 1919 White & Hutton

No. 3862 **Frodsham & Keen.**

Purchased April 1916 ex H.M.S. Montezuma.

18 April 1916 S.D. Neill. Page 6896

26 Oct. 1916 H.MS. Blonde.

29 Sept. 1919 Sold to Messrs. Kelvin, J. White & Hutton.

No. 2055 **John Frodsham.**

Bought on March 25th 1836.

26 April 1836 Swift. Page 365

22 June 1840 Parkinson & Frodsham

23 Nov. 1840 Blazer.

25 Feb. 1842 Volcano.

11 Jan. 1848 Island of Ascension.

9 Oct. 1848 H.M.S. Athol.

27 May 1851 Gossamer.

22 Dec. 1861 Mr. C. Frodsham.

25 May 1862 H.M.S. Trident.

30 July 1862 H.M.S. Rattler. Page 1078

14 Feb. 1870 C. Frodsham.

5 May 1882 H.M.S. Triton.

23 July 1888 H.M.S. Curacoa.

27 April 1889 Cape Observatory.

11 Dec. 1889 H.M.S. Caroline.

6 Sept. 1895 Malta.

10 Aug. 1903 H.M.S.Kent.

9 March 1908 Hong Kong. Page 3425

31 May 1913 Sold to W. Cardall.

No. 2 **W. E. Frodsham.**

20 May 1831 Pike. Page 282

16 Dec. 1835 Beagle. Capt. Fitzroy.

W. E. FRODSHAM CHRONOMETER RECORD

14 Nov.	1836	1836 (On this chronometer the name engraved is W. E. Frodsham).
8 May	1841	Shearwater.
16 April	1843	North American Boundary Line Expedition.
19 Nov.	1846	Transport Maria Soane.
20 March	1849	President.
23 Feb.	1850	H.M.S. Volage.
14 Feb.	1857	H.M.S. Vixen to H.M.S. Herald. Page 833
18 Jan.	1867	H.M.S. Rapid.
12 Jan.	1887	H.M.S. Grappler.
5 July	1888	H.M.S. Mersey.
7 Feb.	1889	H.M.S. Leander.
21 July	1892	H.M.S. Victor Emanuel
28 Dec.	1896	Malta.
29 July	1903	H.M.S. Kent.
13 Nov.	1903	H.M.S. Albermarle. Page 3066
15 Aug.	1911	Taken in exchange by E. Dent & Co.

APPENDIX XVI

THE LANCASHIRE GAUGE

Charles Frodsham's description, taken from *A Few Facts Connected with The Elements of Watch and Clock Making.* 1862.

I found no small difficulty in giving a value to the old Lancashire Movement Gauge; for although I conversed upon the subject with some of the oldest men in the trade, they only treated it as a tool, without regard to any standard of measurement whatever. I at length, however, unravelled its meaning. The Lancashire Movement Gauge, then, is a three inch rule subdivided duodecimally: a watch whose movement is one inch in diameter is said to be O size, and the second inch is subdivided into thirty equal parts or sizes, so that each size is $^{1}/_{30}$th of an inch. Now, although the old duodecimal division was evidently the principle adopted, yet this term would not, by its name, determine the size of the watch, because (the first inch in all cases being dropped) the technical size refers only to the size of the plate, or that upon which the movement is constructed, and not the brass edge or dial plate for which five sizes are added for what is termed the fall, that is for room to allow the works to open and shut in the case. An English 16 size watch is therefore 1 inch + $^{16}/_{30}$ + $^{5}/_{30}$ = 1·7 inches, which shows little connection in point of measure with the technical size of the diameter of the watch.*

Now, had the framers of the Lancashire Gauge called a watch of one inch diameter size 12, and then increased each size by $^{1}/_{12}$th of an inch, we should have had transmitted to us a common standard of measurement, and should have been prevented from falling into technicalities until scarcely any one knows that the Lancashire sizes had their origin in the English inch.

The various heights of pillars are also very numerous and unnecessarily minute, each graduation in height being equal to $^{1}/_{144}$th part of an inch only. They commence at $^{0}/_{6}$, which is equal to $^{1}/_{12}$th of an inch. 0 is the starting point for pillars above 0, and is equal to $\frac{1}{8}$th of an inch or ·125, and thence they proceeded to $^{30}/_{6}$, which is equal to $^{3}/_{12}$ths of an inch, a height of pillar which we see in some of the very thick old watches, technically called " whole plate watches." The calliper of these large watches was brought to great perfection, both as regards mechanical design and good proportions; and it is to their excellence and durability that we owe much of the great repute that English watches are held in all over the world. The economy of space and the acquisition of power were great points with their authors, and we accordingly find that they not only employed the largest barrel possible, but by placing it over the joint of the case, and allowing it to project over the edge of the plate, the utmost extent of room in the case was rendered available.

In the modern introduction of *half and three-quarter plate watches* wherein all the works are level, the packing of large works, and the care required to see

that there is a proper amount of freedom for the balance, etc., is attended with great difficulty, and demands no small amount of judgment and mechanical skill. In the half and three-quarter plate watch, the brass edge now forms a part of the solid plate; it should, therefore, now be taken as the size of the movement, since it is also nearly the size of the dial; and thus, by adopting this single measurement to express the size of the watch, the necessity of a double gauge for the movement is entirely avoided. Moreover, since the movement gauge was based upon the inch divided into thirty equal parts, and the size of a watch is one inch and a certain number of thirtieths of an inch, would it not be better to return to it, and instead of saying 16 size, call it by its proper name, thus :

$$1 \text{ inch} + {}^{16}/_{30} + {}^{5}/_{30} = 1^{21}/_{30} = 1{\cdot}7 \text{ inches ?}$$

What necessity, however, can there be for so large a number of sizes which now differ only by 0·033 of an inch, that is three sizes to the tenth of an inch ? If the odd size only were omitted, we should then have a difference of ·066 or $\frac{2}{3}$rds of a tenth. Surely one-tenth of an inch is a difference small enough between one watch and another to meet the taste of fashion, and certainly quite equal to all the requirements of Horological Science !

In my new gauge, I have adopted the decimal measurement by inches for all parts of the watch; and I now beg to lay before my readers a description of it : – the sizes commence with 1 inch measured at the pillar-plate, which I propose to call size 10, and then propose to increase each consecutive size ${}^{1}/_{10}$th of an inch; 15 size will therefore be $1\frac{1}{2}$ inch, and so on; 20 size etc., which will be 2 inches, instead of at present calling it 30 size, which expresses no intelligible measurement. To the present workmen, it is difficult in the extreme, as we all know, to alter old measures and terms; but since the measure has been lost, and the term size possesses no guiding advantage or instruction, it is certainly better to make all the alterations at once. I am aware, however, that this involves a re-construction of callipers, which is a serious expense of time and trouble, although no one will doubt but that watchmaking will be benefitted by a re-construction of its callipers, which at present are not very satisfactory; and that being admitted, what can facilitate the work so much as the decimal measurement applied to a nomenclature which explains its own meaning ? So certain am I of the value of a common decimal measurement in inches, that its general adoption will, I am sure, be a period marked in English watchmaking, and lead to incalculable improvements and economy, whilst the art will then become a more pleasing employment to all intelligent men engaged in its minute and difficult manufacture.

I shall now offer a few remarks tending to illustrate that these changes will not, in reality, be so difficult as may at first sight appear; and state my reasons for preferring one size of watch to another; and conclude with a comparative table of the old and new sizes, with their equivalent values in French measurement by lines and millimètres.

My new pillar-gauge, commences with the least height of pillar, called 10, implying $^{10}/_{100}$ths or $^{1}/_{10}$th of an inch, each consecutive height then increases one hundredth.

The Lancashire pillar gauge 0=·125 of an inch and corresponds to my $12\frac{1}{2}$ pillar height. The Lancashire movement size agrees with my new gauge in measurement, though not in name, at every third size; — but the subjoined table shows them all in juxta-position.

*The custom adopted by the French and Swiss in speaking of the size of a watch is certainly preferable, because they estimate the size of a watch by the number of lines in the dial.

TABLE of the corresponding SIZES OF ENGLISH WATCHES, taken by actual measurement across the PILLAR-PLATE, and given in English inches and decimals against each of the FOUR technical sizes now in use: viz.—

1. Charles Frodsham's new Movement increases by tenths and half tenths.
2. The Lancashire Movement by thirtieths of an English inch.
3. That by French Lines, each equal to ·0888 inches, or about $\frac{89}{1000}$ths of an Eng. inch.
4. That by Millimètres, each equal to ·03937 inches, or about $\frac{4}{100}$ths of an Eng. inch.

C. Frodsham's New Movement. Technical size. Inches.	Lancashire Sizes. 3 sizes = $\frac{1}{10}$ of an inch. 1 size = ·0333. Technical Numbers. Inches and Decimals.	Value of French Lines in Eng. inches. F.Lines. E.Inches.	Value of Millimètres in Eng. inches. 1 Mill. = 0·03937
10 = 1·00	0 = 1 5/30 or 1·166	10 = 0·888	10 ,, = 0·39371
10½ = 1·05	1 = 1 6/30 ,, 1·200		25·4 ,, = 1·000
11 = 1·10	2 = 1 7/30 ,, 1·233	11 = 0·977	26 ,, = 1·024
11½ = 1·15	3 = 1 8/30 ,, 1·266		27 ,, = 1·063
12 = 1·20	4 = 1 9/30 ,, 1·300	12 = 1·066	28 ,, = 1·102
12½ = 1·25	5 = 1 10/30 ,, 1·333		29 ,, = 1·142
13 = 1·30	6 = 1 11/30 ,, 1·366	13 = 1·154	30 ,, = 1·181
13½ = 1·35	7 = 1 12/30 ,, 1·400	13¾ equal 1·200	31 ,, = 1·220
14 = 1·40	8 = 1 13/30 ,, 1·433	14 = 1·243	32 ,, = 1·260
14½ = 1·45	9 = 1 14/30 ,, 1·466		33 ,, = 1·299
15 = 1·50	10 = 1 15/30 ,, 1·500	15 = 1·332	34 ,, = 1·339
15½ = 1·55	11 = 1 16/30 ,, 1·533		35 ,, = 1·378
16 = 1·60	12 = 1 17/30 ,, 1·566	16 = 1·421	36 ,, = 1·417
16½ = 1·65	13 = 1 18/30 ,, 1·600		37 ,, = 1·457
17 = 1·70	14 = 1 19/30 ,, 1·633	17 = 1·510	38 ,, = 1·496
17½ = 1·75	15 = 1 20/30 ,, 1·666		39 ,, = 1·535
18 = 1·80	16 = 1 21/30 ,, 1·700	18 = 1·598	40 ,, = 1·575
18½ = 1·85	17 = 1 22/30 ,, 1·733		41 ,, = 1·614
19 = 1·90	18 = 1 23/30 ,, 1·766	19 = 1·687	42 ,, = 1·654
19½ = 1·95	19 = 1 24/30 ,, 1·800		43 ,, = 1·693
20 = 2·00	20 = 1 25/30 ,, 1·833	20 = 1·776	44 ,, = 1·732
20½ = 2·05	21 = 1 26/30 ,, 1·866		45 ,, = 1·772
21 = 2·10	22 = 1 27/30 ,, 1·900	21 = 1·865	46 ,, = 1·811
21½ = 2·15	23 = 1 28/30 ,, 1·933		47 ,, = 1·850
22 = 2·20	24 = 1 29/30 ,, 1·966	22 = 1·954	48 ,, = 1·890
22½ = 2·25	25 = 2 0/30 ,, 2·000		49 ,, = 1·929
23 = 2·30	26 = 2 1/30 ,, 2·033	23 = 2·042	50 ,, = 1·969
23½ = 2·35	27 = 2 2/30 ,, 2·066		51 ,, = 2·008
24 = 2·40	28 = 2 3/30 ,, 2·100	24 = 2·136	52 ,, = 2·047
24½ = 2·45	29 = 2 4/30 ,, 2·133		53 ,, = 2·087
25 = 2·50	30 = 2 5/30 ,, 2·166	25 = 2·220	54 ,, = 2·126
	31 = 2 6/30 ,, 2·200		55 ,, = 2·165
	32 = 2 7/30 ,, 2·233	26 = 2·309	56 ,, = 2·205
	33 = 2 8/30 ,, 2·266		57 ,, = 2·244
	34 = 2 9/30 ,, 2·300	27 = 2·398	58 ,, = 2·283
	35 = 2 10/30 ,, 2·333		59 ,, = 2·323
	36 = 2 11/30 ,, 2·366	28 = 2·486	60 ,, = 2·362
	37 = 2 12/30 ,, 2·400		61 ,, = 2·402
	38 = 2 13/30 ,, 2·433		62 ,, = 2·441
	39 = 2 14/30 ,, 2·466		63 ,, = 2·480
	40 = 2 15/30 ,, 2·500		64 ,, = 2·520
			65 ,, = 2·559
			66 ,, = 2·598
			67 ,, = 2·638
			68 ,, = 2·677
			69 ,, = 2·717
			70 ,, = 2·756
			71 ,, = 2·795
			72 ,, = 2·835

APPENDIX XVII

USEFUL HOROLOGICAL TABLES

BY CHARLES FRODSHAM, F.R.A.S., Assoc.C.E.

WATCH AND CHRONOMETER MAKER,

84, STRAND, LONDON:

To which is added, Tables of the Comparison of Thermometers, Melting and Boiling Points, &c., &c.: extracted from the Works of Drs. Ure, Gregory, Daniell, and other authentic sources.

(For private circulation only.)

DILATATION OF DIFFERENT SUBSTANCES BY HEAT,

From the temperature of freezing to boiling water.

SUBSTANCES.	Dilatation for a length equal to unity.
Platina	$\frac{1}{1178}$ ·00085055
English Flint Glass	$\frac{1}{1232}$ ·00081166
French Glass with lead	$\frac{1}{1147}$ ·00087199
Glass tube with lead (also deal rod)	$\frac{1}{1115}$ ·00089694
Steel rod, not tempered, wire drawn	$\frac{1}{926}$ ·00107915
Zinc rod wire drawn	$\frac{1}{308}$ ·00324675
Steel rod to Zinc rod (the two former) 1 to 3	$\frac{308}{926}$ ·33333333
Cast Iron	$\frac{1}{900}$ ·00111111
Soft Iron forged	$\frac{1}{819}$ ·00122045
Iron Rod, wire drawn	$\frac{1}{812}$ ·00123504
Steel hardened and tempered at 450° and annealed at 150° of Fahr.	$\frac{1}{807}$ ·00123956
Gold (procured by parting)	$\frac{1}{682}$ ·00146006
Copper	$\frac{1}{582}$ ·00171821
Brass { mean of the results given by **10** different experimenters }	$\frac{1}{524}$ ·00190840
Silver, cupelled	$\frac{1}{523}$ ·00190974
English Tin	$\frac{1}{460}$ ·00217300
Lead	$\frac{1}{351}$ ·00284900
Mercury by volume	$\frac{1}{55}$ ·018018
* Mercury in Glass, from 5·73 to 5·81 times that of Steel rod	
Water	$\frac{1}{24}$ ·0433
Alcohol	$\frac{1}{9}$ ·011

* The Gridiron Pendulum, by Harrison, A.D. 1721, and the Zinc and Steel rod Pendulum, first introduced by Arnold in the Clock made for the Observatory where Tycho Brahe was the Astronomer, continue to be the favorite kinds of compensation pendulums for Astronomical Clocks in France; and many exceed one hundred of their use. In England, however, Graham's Mercurial Pendulum is preferred, on account of its greater simplicity, accuracy, and facility of adjustment for temperature. The average height of the Mercurial column is 6½ inches; the exact dimensions being mainly dependant upon the strength of the suspending spring; of which the proportions, as given by Arnold, are from 8 to 10 thousandths of an inch in thickness, 4 to 4½ tenths broad, and 7 tenths long. W. J. Frodsham, F.R.S., by a set of experiments specially directed to this inquiry, determined the most suitable dimensions to be 8 tenths of an inch long, 45 hundredths broad, and 3 thousandths thick.

SPECIFIC GRAVITIES.

Water (the standard)	1·00
Platina	21·50
Gold, hammered	19·35
„ cast	19·25
Mercury, at 60°	13·58
Lead	11·35
Silver	10·47
Copper	8·80
Brass, from 7·80 to 8·40	
Steel	7·82
Bar Iron	7·78
Cast Iron	7·21
Tin	7·30
Zinc	7·00
Diamond heavy	3·53
(rose coloured	
„ (light)	3·50
English Flint Glass	3·33
Marble	2·75
Flint	2·60
Ivory	1·90
Dutch Box	1·33
Lignum vitæ	1·33
Ebony	1·30

Relative power of Metals for conducting heat:

Gold the best conductor being represented by 1000.

Gold	1000	Iron & Steel	374
Silver	973		
Platina	971	Zinc	363
Copper	298	Tin	304
Lead	180		

FUSING POINTS.

	Wedg.	Fahr.
Cast Iron thoroughly melted	150°	= 20577°
„ begins to melt	130	17977
Welding heat of Iron	95	13427
Fine Gold melts	32	5237
Fine Silver „	28	4717
Copper „	27	4587
Brass „	21	3807
Red heat, visible by day-light		1077
Iron red-hot in the twilight		884
Zinc melts		700
Lead „		612
Bismuth „		480
Tin „		442

SOLDERS of different degrees of fusibility.

	Fahr.
Tin 3 parts, Lead 5, Bismuth 8, Mercury 2½ (Pearl Solder)	134°
Lead 2, Tin 4, Bismth 5	
Lead 5, Tin 3, Bismth 8 } in boiling water	212
Lead 1, Tin 4, Bismth 5	246
Tin 1, Bismuth 1	280
Tin 3, Lead 2 (Tin Solder)	334
Tin 2, Bismuth 1	392

BOILING POINTS.

Mercury	660° F.
Linseed Oil	640
Sulphur	570
Water	212
Alcohol	174
Ether	100

SHELL LAC—began to soften at 180° F.; was soft and plastic but showed no signs of fusion at 212°; and boiled up at above 300° F.

Comparative weights of an inch length of the following WIRES.

SUBSTANCES.	*Steel.*	*Brass.*	*Gold.*	*Platina.*
SPECIF. GRAV.	7·82	8·32	19·35	21·50
Hundths. inch.	Grains.	Grains.	Grains.	Grains.
Diam. ·01	0·2	0·2	0·4	0·4
·02	0·6	0·6	1·5	1·7
·03	1·4	1·5	3·5	3·8
·04	2·5	2·6	6·2	6·8
·05	3·8	4·1	9·7	10·7
·06	5·6	5·9	13·9	15·4
·07	7·6	8·1	19·0	21·0
·08	9·9	10·5	24·8	27·3
·09	12·5	13·3	31·4	34·7
·10	15·4	16·4	38·7	42·6
·11	18·7	20·0	47·0	51·7
·12	22·3	23·7	55·8	61·5
·13	26·2	27·8	65·5	72·0
·14	30·3	32·3	76·0	84·0
·15	34·8	37·0	87·2	96·0
·16	38·6	42·2	99·2	109
·17	44·8	47·8	112·0	123
·18	50·2	53·5	125·6	138
·19	56·0	59·5	140·0	154
·20	62·0	66·0	154·5	170
·22	75·0	79·5	187	206
·24	89·0	95·0	223	246
·26	104·0	110·0	262	288
·28	121·0	129·0	303	334
·30	139·0	148·0	248	384

Correspondence of Thermometers.

Fahr. 212°	Reaum. = 80°	Cent. = 100°
122	40	50
119	38·7	48·3
116	37·3	46·7
113	36·0	45·0
110	34·7	43·3
107	33·3	41·7
104	32·0	40·0
101	30·7	38·3
98	29·3	36·7
95	28·0	35·0
92	26·7	33·3
89	25·3	31·7
86	24·0	30·0
83	22·7	28·3
80	21·3	26·7
77	20·0	25·0
74	18·7	23·3
71	17·3	21·7
68	16·0	20·0
65	14·7	18·3
62	13·3	16·7
59	12·0	15·0
56	10·7	13·3
53	9·3	11·7
50	8·0	10·0
47	6·7	8·3
44	5·3	6·7
41	4·0	5·0
38	2·7	3·3
35	1·3	1·7
32	0·0	0·0

$$\frac{\text{Deg. of C.} \times 9}{5} + 32 \text{ or } \frac{\text{deg. of R.} \times 9}{4} + 32 = \text{deg. of Fahr.}$$

$$\frac{(\text{Deg. of F.} - 32) \times 5}{9} \text{ or } \frac{\text{deg. of R.} \times 9}{4} = \text{deg. of C.}$$

$$\frac{(\text{Deg. of F.} - 32) \times 4}{9} \text{ or } \frac{\text{deg. of C.} + 4}{5} = \text{deg. of R.}$$

Example. $\frac{65°\text{R} \times 9}{5} + 32 = 140°$ F.

TEMPERING HEATS FOR STEEL.

Steel may be tempered In a Metallic Bath, In Fused Tin or Solid Oil, heated to the proper degree. The Colours are very imperfect indications of the requisite temperature. Perfection of temper depends not only upon the temperature, but upon the time employed in the operation.

No.	Temp.	Colours.	Adapted for
1	430° Fahr.	Faint Yellow	Lancets
2	450°	Pale Straw	A little softer
3	470°	Full Yellow	Razors and Surgeons' Instruments
4	490°	Brown Yellow	Small Pinions and Arbors
5	510°	Do. with purple spots	Cold Chisels and Shears for cutting Iron
6	530°	Purple	Large Pinions and Arbors
7	550°	Bright Blue	Swords and Watch Springs
8	560°	Full Blue	Chrs. and Watch Balance Springs
*9	600° to 660°	Dark Blue, verging on pale Black, technically termed White	Chronometer Balance Springs

FOREIGN WEIGHTS AND MEASURES.

	Av. oz.
French poids de Marc	= 17·26
Castile pound	= 16·21
Cologne do.	= 16·49
Vienna do.	= 19·71
Amsterdam do.	= 17·34
Swedish do.	= 14·98
Russian do.	= 14·45
Fr. Gramme, 18·83 Fgrs	= 15·44 Tr.grs
Killogramme . 50·75 lb. av.	
Litre in Imp. Pts. 1·76	

	Eng. in.
Metre	= 39·371
Millimetre ($\frac{1}{25}$ in. nearly)	= 0·039
Fr. ft. of 12 in. or 144 lines	= 12·789
Rhenish foot	= 12·36
Vienna do.	= 12·45
Amsterdam do.	= 11·15
Swedish do.	= 11·79
Russian do.	= 13·95
Chinese do.	= 12·61
Vare de Castille	= 32·95

TABLE SHOWING THE DIAMETER AND WEIGHT OF BALANCE SUITED TO DIFFERENT KINDS OF WATCHES AND CHRONOMETERS,

According to their diameter of barrel, height of pillar, vibrations per hour, turns in the fusee, diameter of centre pinion, &c. &c.—circumstances which affect the power of the watch, and, consequently, the dimensions and weight of the balance required to produce the necessary momentum: the whole based upon the experiance acquired in the construction of some thousands of Watches and Chronometers,

by CHARLES FRODSHAM, F.R.A.S., Assoc.C.E., Chronometer Maker, 84, Strand, LONDON.

[ENTERED AT STATIONERS' HALL.]

LEVER TRAINS with angle of escapement about 36° and vib. 1½ turns, with hardened and tempered Springs.

Trade Movement. No. and size of Pillar Plate corresponding with that of C. F. in the next column.	Size and No. of the Pillar Plate in C. F. new series movement.	Technical height of Pillar.	Height of the Pillar in 100ths of an inch.	Diameter of Barrel in 100ths of an inch.	Diameter of Escape Wheel of 15,18, & 20 Teeth. in 100ths of an in.	14,400 vib. ☿ H. 240 ☿ Min. 4th w. Esc p. Esc w	15,120 vib. ☿ H. 252 ☿ Min. 4th w. Esc p. Esc w	15,660 vib. ☿ H. 261 ☿ Min. 4th w. Esc p. Esc w	16,200 vib. ☿ H. 270 ☿ Min. 4th w. Esc p. Esc w	16,800 vib. ☿ H. 280 ☿ Min. 4th w. Esc p. Esc w	17,280 vib. ☿ H. 288 ☿ Min. 4th w. Esc p. Esc w	18,000 vib. ☿ H. 300 ☿ Min. 4th w. Esc p. Esc w	C. F. New Series Movement.	DUPLEX, vib. 1⅛	MARINE CHRONOMETERS, POCKET / Ditto; VIBRATIONS 1½ TURNS.	Loss on Time ☿ min. Pillars of 0.
					TEETH.									18,000 vib. ☿ H. 4th w. Esc p. Esc w	18,000 vib. ☿ H. 4th w. Esc p. Esc w; 14,400 vib. ☿ H. 4th w. Esc p. Esc w	
	Inches. No.		100ths.	100ths.	15 18 20	Diam. Wt. Sps.	Diam. Wt. Sps.	Diam. Wt. Sps.	Diam. Wt. Sps.	Diam. Wt. Sps.	Diam. Wt. Sps.	Diam. Wt. Sps.	No. 0.	Diam. Wt. Sps.	Diam. Wt. Sps. Dm. Wt. Wt. Dm. Sps.	Sec.
No. 0	1·16 4	0	13½	47	20 24	47 8	47 7½	47 6¾	47 6½	45½ 6¾	44 6½	44 5¾	4 0	47 5½	These Diameters are given as large as can possibly be admitted in a full pillar, but when space allows it is advisable to increase them ⅞ per cent. to prevent the balance from overrunning. Diameter constant for each size. Weight by calculation according to height of Pillar. Weight taken at a mean of the two former. Diameter found by calculation.	
	1·16 4	⅛	11	47	20 24	44 5½	44 5	44 4¾	44 4½	42½ 4¾	41 4½	41 4	4 ⅛	44 4		
2⅓	1·24 6	0	13½	50½	21 25	50 8½	50 7½	50 7	50 6½	48 6¾	47 6½	47 6	6 0	50 5⅞		0·0
	1·24 6	⅛	11	50½	21 25	47 5½	47 5¼	47 4¾	47 4½	45½ 4½	44 4½	44 4½	6 ⅛	47 4		
4⅔	1·32 8	0	13½	54	22 27	53½ 8¼	53½ 8	53½ 7½	53½ 7	51½ 7	50 7	50 6½	8 0	53 6½		5·8
	1·32 8	⅛	11	54	22 27	51 6½	51 5¾	51 5½	51 5	49 5	48 5	48 4½	8 ⅛	50 4½		
7	1·40 10	0	13½	57½	24 28	56½ 9½	56½ 8½	56½ 8	56½ 7½	54½ 7½	53 7½	53 7	10 0	56½ 6¾		5·5
	1·40 10	⅛	11	57½	24 28	54 7	54 6½	54 6	54 5½	52 5½	50½ 5½	50½ 5	10 ⅛	54 5		
9½	1·48 12	0	13½	61	25 30	60 10	60 9½	60 8½	60 8	58 8	56 8	56 7½	12 0	60 7		5·1
	1·48 12	⅛	11½	61	25 30	58½ 8¼	58½ 8	58½ 7½	58 7	56 7	54½ 7	54½ 6½	12 ⅛	58½ 6¼		
12	1·56 14	0	13½	64½	26 32	63 10¼	63 9½	63 9	63 8½	61 8¼	59 8½	59 8	14 0	63 7½	63 10½ 63 16½ 13 69	4·8
	1·56 14	⅛	11½	64½	26 32	61½ 9¼	61½ 8½	61½ 8	61½ 7½	59½ 7½	57½ 7½	57½ 7	14 ⅛	61½ 6½	63 9½ 63 14½ 13 71	
14	1·64 16	⅛	11½	68	28 33	65 10	65 9½	65 8½	65 8	63 8	61 8	61 7½	16 ⅛	65 7	66½ 10½ 66½ 16 13 73½	4·6
	1·64 16	0	13½	68	28 33	66½ 11½	66½ 10½	66½ 9½	66½ 9	64 9	62 9	62 8½	16 0	65 8	66½ 11½ 66½ 18 14½ 73½	
	1·64 16		14	68	28 33	66½ 12	66½ 11	66½ 10½	66½ 10	64 9½	62 9½	62 8¾	16 ⅛	65 8½	66½ 12 66½ 19 15½ 73½	
	1·64 16		14¾	68	28 33	66½ 12¾	66½ 11¾	66½ 10¾	66½ 10	64 10	62 10	62 9¼	16 ⅛	65 9	66½ 12⅜ 66½ 20 16½ 73½	
	1·64 16		15½	68	28 33	66½ 13¼	66½ 12	66½ 11¼	66½ 10½	64 10½	62 10½	62 9¾	16 ⅛	65 9½	66½ 13½ 66½ 21 17 73½	
	1·64 16		16½	68	28 33	66½ 14	66½ 12¾	66½ 11¾	66½ 11	64 11	62 11	62 10	16 ⅛	65 10	66½ 14¼ 66½ 22 18 73½	
16⅔	1·72 18		14	71½	29 35 39½	70 12¾	70 11¼	70 10⅝	70 10	67½ 10	65½ 10	65½ 9½	18 ⅛	68 9	70 13 70 20½ 16½ 77½	4·4
	1·72 18		14¾	71½	29 35 39½	70 13½	70 12	70 11¼	70 10½	67½ 10½	65½ 10½	65½ 9¾	18 ⅛	68 9¼	70 13¾ 70 21½ 17¼ 77½	
	1·72 18		15¼	71½	29 35 39½	70 14	70 12¾	70 11¾	70 11	67½ 11	65½ 11	65½ 10	18 ⅛	68 9¾	70 14½ 70 22½ 18½ 77½	
	1·72 18		16½	71½	29 35 39½	70 15	70 13½	70 12½	70 11¾	67½ 11¾	65½ 11½	65½ 10½	18 ⅛	68 10¼	70 16 70 23½ 19¼ 77½	
	1·72 18		17¾	71½	29 35 39½	70 16	70 14¼	70 13¾	70 12¾	67½ 12¾	65½ 12¾	65½ 11¾	18 ⅛	68 11¼	70 16½ 70 25½ 21 77½	
19¼	1·80 20		14¾	75	30 36 40	73 14	73 12¾	73 11⅝	73 11	70 11	68 11	68 10	20 ⅛	71 10	73 15 73 22 18 80½	4·2
	1·80 20		15¼	75	30 36 40	73 14½	73 13¼	73 12¼	73 11½	70 11½	68 11½	68 10½	20 ⅛	71 10¾	73 14¾ 73 23½ 19 80½	
	1·80 20		16¼	75	30 36 40	73 15	73 14	73 13	73 12	70 12	68 12	68 11	20 ⅛	71 11¾	73 15½ 73 24½ 20 80½	
	1·80 20		17¾	75	30 36 40	73 17	73 15½	73 14½	73 13½	70 13½	68 13½	68 12	20 ⅛	71 12	73 16⅜ 73 26½ 21⅜ 80½	
	1·80 20		19¼	75	30 36 40	73 18½	73 16⅜	73 15½	73 14½	70 14½	68 14½	68 13	20 ⅛	71 13	73 18½ 73 28½ 23½ 80½	
21⅔	1·88 22		16½	78½	32 38 42	76 16	76 14¾	76 13¾	76 12¾	73½ 12¾	71 12¾	71 11¾	22 ⅛	74 11½	76 16½ 76 25½ 21 84	4·1
	1·88 22		17¾	78½	32 38 42	76 17¾	76 16	76 15	76 14	73½ 14	71 14	71 13	22 ⅛	74 12½	76 17¾ 76 28 23 84	
	1·88 22		19¼	78½	32 38 42	76 19½	76 17½	76 16½	76 15½	73½ 15½	71 15½	71 14	22 ⅛	74 13½	76 19½ 76 30½ 25 84	
	1·88 22	⅛	20½	78½	32 38 42	76 20½	76 18½	76 17½	76 16½	73½ 16½	71 16½	71 15	22 ⅛	74 14½	76 20¾ 76 32½ 27 84	
24½	1·96 24		16½	82	33 40 44	80 16¾	80 15½	80 14½	80 13½	77 13½	74½ 13½	74½ 12	24 ⅛	78 11⅜	80 17 80 26½ 22 88½	4·0
	1·96 24		17½	82	33 40 44	80 18½	80 16¾	80 15½	80 14½	77 14½	74½ 14½	74½ 13½	24 ⅛	78 13	80 18½ 80 29 23½ 88½	
	1·96 24		19½	82	33 40 44	80 20	80 18	80 16⅝	80 15⅝	77 15⅝	74½ 15⅝	74½ 14½	24 ⅛	78 14½	80 20 80 31½ 25½ 88½	
	1·96 24	⅛	20½	82	33 40 44	80 21½	80 19½	80 18½	80 17	77 17	74½ 17	74½ 16½	24 ⅛	78 15½	80 21½ 80 34½ 28 88½	

WIDTH OR DEPTH OF RIM OF COMPENSATION BALANCE SUITED TO THE VARIOUS HEIGHTS OF PILLAR.

Heights of Pillar in 100ths of an Inch	8/0 19¼	7/0 18½	6/0 17¾	5/0 17	4/0 16½	3/0 15½	2/0 14	1/0 14	0 13½	1/0 12½	2/0 11¾	3/0 11	4/0 10½	5/0 9½	6/0 8¾
Chronometers with high Springs	95	92	88	84	80	76	72	68	65						
Chronometers with flat Springs	88	84½	81	77½	74	70½	67	63½	60	56	53	50	47	44	41
Levers and Duplex, 4th wh. sunk flush with the pil. pl.	79	76	73	70	67	64	61	58	55	52	49	46	43	40	37
Ditto, balance dished on both sides	90	90	85	85	80	80	75	75	65	60	60	55	55	50	50
Trade Calliper, Improved by C. F., 4th wheel not sunk	74	71	68	65	62	59	56	53	50	47	44	41	38	35	33

Thousandths of an Inch.

BARRELS AND BALANCES OF TWO DAYS MARINE CHRONOMETERS.

	Barrels. Inches.	Balances. Outer comp. rim. DIAM. Inches.	Balances. Outer comp. rim. WT. Grs.
Large size	1·56 by 0·72	1·180	142
Medium	1·37 " 0·66	1·100	120
Small	1·25 " 0·52	1·050	85

BALANCE SPRINGS for TWO DAYS MARINE CHRONOMETERS.

For the Large size, the Springs are formed on a block of $\frac{45}{1000}$ of an inch diam., have 11 turns, and require about 15½ inches of wire of from 19 to 20 thousandths of an inch wide and 12 thick. (20½ inches of this wire weighed 7 grains.

For the Medium size, the springs are formed on a block of the same diam. and with the same substance of wire, but with 12 and sometimes 13 turns, which require from 16 to 18 inches of wire.

For the Small size, the Springs are formed on a block of $\frac{42}{1000}$ of an inch diam., have 11 turns and require about 14 inches of wire of 17 thousandths of an inch wide and 9 thick. (21 inches weighed 5 grs.)

The Diameters given in this table are to the extremity of the rim if a gold balance, and to the extremity of the screws if a compensation balance.

In MARINE CHRONOMETERS,—the diameter given is that of the outer compensation rim.

The gradations in the strength of the balance spring wire, from number to number, is about five seconds per minute. The last column in the Table shows what loss of time in sec. per min. would result from the increased diameter and weight of balance, in each of the sizes given in the table and pillars of 0, upon the supposition that the same balance spring is applied thereto with which the watch two sizes smaller goes to time.

A SET OF FIVE TABLES FOR FACILITATING THE OPERATION OF TIMING WATCHES AND CHRONOMETERS.

THESE TABLES, though calculated expressly for attaining the above object, are not restricted to that single use; for their construction being based upon the entire Theory of the balance, including every variety of Diameter, Weight and Velocity, they will be found to answer a great number of other useful inquiries, which will gradually suggest themselves during their use.

TABLES G.—Nos. I. and II. show, approximately, how much a CHRONOMETER or WATCH BALANCE requires to be INCREASED or DIMINISHED in WEIGHT, to bring the watch to time with the particular BALANCE SPRING UNDER TRIAL.

The ERROR per MINUTE, upon which the correction depends, must be taken as accurately as possible.

TABLE G.—No. I. FOR GAINING WATCHES.

Correction for ONE SEC. per MIN. $= \frac{1}{4\frac{1}{2}}$ { OF THE ENTIRE WEIGHT OF THE BALANCE.

Wgt. of Balance in grains	SECONDS IN ERROR.					TENTHS OF SECONDS IN ERROR.									
	5″	4″	3″	2″	1″	$\frac{9}{10}$	$\frac{8}{10}$	$\frac{7}{10}$	$\frac{6}{10}$	$\frac{5}{10}$	$\frac{4}{10}$	$\frac{3}{10}$	$\frac{2}{10}$	$\frac{1}{10}$	
Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	
150	17·25	13·80	10·35	6·90	3·45	3·11	2·76	2·42	2·07	1·73	1·38	1·04	·69	·35	150
140	16·10	12·88	9·66	6·44	3·22	2·90	2·58	2·25	1·93	1·61	1·29	·97	·64	·32	140
130	14·95	11·96	8·97	5·98	2·99	2·69	2·39	2·09	1·79	1·50	1·20	·90	·60	·30	130
120	13·80	11·04	8·28	5·52	2·76	2·48	2·21	1·93	1·66	1·38	1·10	·83	·55	·28	120
110	12·65	10·12	7·59	5·06	2·53	2·28	2·02	1·77	1·52	1·27	1·01	·76	·51	·25	110
100	11·50	9·20	6·90	4·60	2·30	2·07	1·84	1·61	1·38	1·15	·92	·69	·46	·23	100
95	10·92	8·74	6·57	4·37	2·19	1·96	1·75	1·53	1·31	1·10	·88	·66	·43	·22	95
90	10·35	8·28	6·22	4·14	2·07	1·86	1·66	1·45	1·24	1·04	·83	·62	·41	·21	90
85	9·77	7·82	5·87	3·91	1·96	1·76	1·56	1·37	1·17	·98	·79	·59	·39	·19	85
80	9·20	7·36	5·52	3·68	1·84	1·66	1·47	1·29	1·10	·92	·74	·55	·37	·18	80
75	8·62	6·90	5·18	3·45	1·73	1·55	1·38	1·21	1·04	·86	·69	·52	·34	·17	75
70	8·05	6·44	4·83	3·22	1·61	1·45	1·29	1·13	·97	·80	·64	·48	·32	·16	70
65	7·46	5·98	4·49	2·99	1·50	1·34	1·19	1·05	·90	·75	·60	·45	·30	·15	65
60	6·90	5·52	4·14	2·76	1·38	1·24	1·10	·97	·83	·69	·55	·41	·28	·14	60
50	5·75	4·60	3·45	2·30	1·15	1·03	·92	·80	·69	·58	·46	·35	·23	·12	50
40	4·60	3·68	2·76	1·84	·92	·83	·74	·64	·55	·46	·37	·28	·18	·09	40
30	3·45	2·76	2·07	1·38	·69	·62	·55	·48	·41	·35	·28	·21	·14	·07	30
20	2·30	1·84	1·38	·92	·46	·41	·37	·32	·28	·23	·18	·14	·09	·05	20
19	2·18	1·75	1·31	·87	·44	·39	·35	·30	·27	·22	·17	·13	·08	·04	19
18	2·07	1·66	1·24	·83	·41	·37	·33	·29	·25	·21	·16	·13	·08	·04	18
17	1·96	1·57	1·17	·78	·39	·35	·31	·27	·24	·20	·15	·12	·08	·04	17
16	1·84	1·48	1·10	·73	·37	·33	·29	·26	·22	·18	·14	·11	·07	·04	16
15	1·73	1·38	1·04	·69	·35	·31	·27	·24	·21	·17	·14	·11	·07	·03	15
14	1·61	1·29	·97	·64	·32	·29	·26	·23	·19	·16	·13	·10	·06	·03	14
13	1·50	1·20	·90	·60	·30	·27	·24	·21	·18	·15	·12	·09	·06	·03	13
12	1·38	1·10	·83	·55	·28	·25	·22	·19	·17	·14	·11	·08	·06	·03	12
11	1·27	1·01	·76	·51	·25	·23	·20	·18	·15	·13	·10	·08	·05	·03	11
10	1·15	·92	·69	·46	·23	·21	·18	·16	·14	·12	·09	·07	·05	·02	10
9	1·04	·83	·62	·41	·21	·19	·17	·15	·12	·10	·08	·06	·04	·02	9
8	·92	·74	·55	·37	·18	·17	·15	·13	·11	·09	·07	·06	·04	·02	8
7	·81	·64	·48	·32	·16	·15	·13	·11	·10	·08	·06	·05	·03	·02	7
6	·69	·55	·41	·28	·14	·12	·11	·10	·08	·07	·06	·04	·03	·01	6
5	·57	·46	·35	·23	·12	·10	·09	·08	·07	·06	·05	·04	·02	·01	5

TABLE G.—No. II. FOR LOSING WATCHES.

Correction for ONE SEC. per MIN. $= \frac{1}{3\frac{1}{0}}$ { OF THE ENTIRE WEIGHT OF THE BALANCE.

Wgt. of Balance in grains	SECONDS IN ERROR.					TENTHS OF SECONDS IN ERROR.									
	5″	4″	3″	2″	1″	$\frac{9}{10}$	$\frac{8}{10}$	$\frac{7}{10}$	$\frac{6}{10}$	$\frac{5}{10}$	$\frac{4}{10}$	$\frac{3}{10}$	$\frac{2}{10}$	$\frac{1}{10}$	
Grs	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	
150	15·00	12·00	9·00	6·00	3·00	2·70	2·40	2·10	1·80	1·50	1·20	·90	·60	·30	150
140	14·00	11·20	8·40	5·60	2·80	2·52	2·24	1·96	1·68	1·40	1·12	·84	·56	·28	140
130	13·00	10·40	7·80	5·20	2·60	2·34	2·08	1·82	1·56	1·30	1·04	·78	·52	·26	130
120	12·00	9·60	7·20	4·80	2·40	2·16	1·92	1·68	1·44	1·20	·96	·72	·48	·24	120
110	11·00	8·80	6·60	4·40	2·20	1·98	1·76	1·54	1·32	1·10	·88	·66	·44	·22	110
100	10·00	8·00	6·00	4·00	2·00	1·80	1·60	1·40	1·20	1·00	·80	·60	·40	·20	100
95	9·50	7·60	5·70	3·80	1·90	1·71	1·52	1·33	1·14	·95	·76	·57	·38	·19	95
90	9·00	7·20	5·40	3·60	1·80	1·62	1·44	1·26	1·08	·90	·72	·54	·36	·18	90
85	8·50	6·80	5·10	3·40	1·70	1·53	1·36	1·19	1·02	·85	·68	·51	·34	·17	85
80	8·00	6·40	4·80	3·20	1·60	1·44	1·28	1·12	·96	·80	·64	·48	·32	·16	80
75	7·50	6·00	4·50	3·00	1·50	1·35	1·20	1·05	·90	·75	·60	·45	·30	·15	75
70	7·00	5·60	4·20	2·80	1·40	1·26	1·12	·98	·84	·70	·56	·42	·28	·14	70
65	6·50	5·20	3·90	2·60	1·30	1·17	1·04	·91	·78	·65	·52	·39	·26	·13	65
60	6·00	4·80	3·60	2·40	1·20	1·08	·96	·84	·72	·60	·48	·36	·24	·12	60
50	5·00	4·00	3·00	2·00	1·00	·90	·80	·70	·60	·50	·40	·30	·20	·10	50
40	4·00	3·20	2·40	1·60	·80	·72	·64	·56	·48	·40	·32	·24	·16	·08	40
30	3·00	2·40	1·80	1·20	·60	·54	·48	·42	·36	·30	·24	·18	·12	·06	30
20	2·00	1·60	1·20	·80	·40	·36	·32	·28	·24	·20	·16	·12	·08	·04	20
19	1·90	1·52	1·14	·76	·38	·34	·30	·27	·23	·19	·15	·11	·08	·04	19
18	1·80	1·44	1·08	·72	·36	·32	·29	·25	·22	·18	·14	·10	·07	·04	18
17	1·70	1·36	1·12	·68	·34	·31	·27	·24	·20	·17	·14	·10	·07	·03	17
16	1·60	1·28	·96	·64	·32	·29	·26	·22	·19	·16	·13	·10	·06	·03	16
15	1·50	1·20	·90	·60	·30	·27	·24	·21	·18	·15	·12	·09	·06	·03	15
14	1·40	1·12	·84	·56	·28	·25	·22	·20	·17	·14	·11	·08	·06	·03	14
13	1·30	1·04	·78	·52	·26	·23	·21	·18	·16	·13	·10	·08	·05	·03	13
12	1·20	·96	·72	·48	·24	·22	·19	·17	·14	·12	·10	·07	·05	·02	12
11	1·10	·88	·66	·44	·22	·20	·18	·15	·13	·11	·09	·07	·04	·02	11
10	1·00	·80	·60	·40	·20	·18	·16	·14	·12	·10	·08	·06	·04	·02	10
9	·90	·72	·54	·36	·18	·15	·14	·13	·11	·09	·07	·05	·04	·02	9
8	·80	·64	·48	·32	·16	·14	·13	·11	·10	·08	·06	·05	·03	·02	8
7	·70	·56	·42	·28	·14	·13	·11	·10	·08	·07	·06	·04	·03	·01	7
6	·60	·48	·36	·24	·12	·11	·10	·08	·07	·06	·05	·04	·02	·01	6
5	·50	·40	·30	·20	·10	·09	·08	·07	·06	·05	·04	·03	·02	·01	5

TABLE G—No. III.

For CIRCULAR COMPENSATION WEIGHTS, applied on the edge of the Balance; equal portions being within and without the rim.

The Fractions forming the correction refer to the weight of the balance in the state it gives the error, with the Mean-time Screws in it.

SECONDS of Error per MIN.

Gaining.

26 *sec.* 25 24 } add an equal weight.

23 .. add .. $\frac{1}{11}$

22 .. " .. $\frac{1}{11}$

21 .. " .. $\frac{1}{12}$

20 .. " .. $\frac{1}{13}$

19 .. " .. $\frac{1}{14}$

18 .. " .. $\frac{1}{15}$

17 .. " .. $\frac{1}{16}$

16 .. " .. $\frac{1}{17}$

15 .. " .. $\frac{1}{18}$

14 .. " .. $\frac{1}{19}$

13 .. " .. $\frac{1}{21}$

12 .. " .. $\frac{1}{23}$

11 .. " .. $\frac{1}{25}$

10 .. " .. $\frac{1}{28}$

9 .. " .. $\frac{1}{31}$

8 .. " .. $\frac{1}{35}$

7 .. " .. $\frac{1}{41}$

6 .. " .. $\frac{1}{48}$

5 .. " .. $\frac{1}{58}$

4 .. " .. $\frac{1}{73}$

3 .. " .. $\frac{1}{98}$

2 .. " .. $\frac{1}{145}$

1 .. " .. $\frac{1}{290}$

Losing.

1 take away $\frac{1}{302}$

2 .. " .. $\frac{1}{153}$

3 .. " .. $\frac{1}{102}$

4 .. " .. $\frac{1}{78}$

5 .. " .. $\frac{1}{63}$

6 .. " .. $\frac{1}{53}$

7 .. " .. $\frac{1}{45}$

8 .. " .. $\frac{1}{40}$

9 .. " .. $\frac{1}{36}$

10 .. " .. $\frac{1}{33}$

TABLE G.—No. IV. shows the available Regulating Power of the two Mean-time Screws of a Compensation Balance.

This power chiefly depends upon the relation which their united weight bears to the entire weight of the balance, and the number of threads per inch in the Screw; and also, to a small extent, upon the shape of the Screw.

Effect per Hour on the time of the Watch caused by one half turn of each Mean-time Screw.

CHRONOMETERS. WATCHES.	Threads per Inch.	WEIGHT OF THE MEAN-TIME SCREWS IN PARTS OF THE BALANCE.												
		$\frac{1}{8}$	$\frac{1}{9}$	$\frac{1}{10}$	$\frac{1}{11}$	$\frac{1}{12}$	$\frac{1}{13}$	$\frac{1}{14}$	$\frac{1}{15}$	$\frac{1}{16}$	$\frac{1}{17}$	$\frac{1}{18}$	$\frac{1}{19}$	$\frac{1}{20}$
		Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
	100	4·8	4·3	3·9	3·6	3·3	3·0	2·8	2·6	2·5	2·3	2·2	2·1	2·0
	110	4·4	3·9	3·6	3·2	3·0	2·8	2·6	2·4	2·3	2·1	2·0	1·9	1·8
	120	4·0	3·6	3·3	3·0	2·7	2·5	2·4	2·2	2·1	1·9	1·8	1·7	1·6
	130	3·7	3·3	3·0	2·8	2·5	2·3	2·2	2·0	1·9	1·8	1·7	1·6	1·5
	140	3·4	3·1	2·8	2·6	2·3	2·2	2·0	1·9	1·8	1·7	1·6	1·5	1·4
	150	3·2	2·9	2·6	2·4	2·2	2·0	1·9	1·8	1·7	1·6	1·5	1·4	1·3
	160	3·0	2·7	2·4	2·2	2·0	1·9	1·8	1·7	1·6	1·5	1·4	1·3	1·2
	170	2·8	2·5	2·3	2·1	1·9	1·8	1·7	1·6	1·5	1·4	1·3	1·2	1·2
	180	2·7	2·4	2·2	2·0	1·8	1·7	1·6	1·5	1·4	1·3	1·2	1·2	1·1
	190	2·5	2·3	2·1	1·9	1·7	1·6	1·5	1·4	1·3	1·2	1·2	1·1	1·0
	200	2·4	2·2	2·0	1·8	1·6	1·5	1·4	1·3	1·2	1·2	1·1	1·0	1·0
	210	2·3	2·1	1·9	1·7	1·6	1·4	1·3	1·3	1·2	1·1	1·0	1·0	0·9
	220	2·2	2·0	1·8	1·6	1·5	1·4	1·3	1·2	1·1	1·1	1·0	·9	0·9
	230	2·1	1·9	1·7	1·5	1·4	1·3	1·2	1·2	1·1	1·0	1·0	·9	0·9
	240	2·0	1·8	1·6	1·5	1·4	1·3	1·2	1·1	1·0	1·0	·9	·9	0·8
	250	1·9	1·7	1·6	1·4	1·3	1·2	1·1	1·1	1·0	·9	·9	·8	0·8
	260	1·8	1·6	1·5	1·4	1·3	1·2	1·1	1·0	1·0	·9	·9	·8	0·8

CORRECTION FOR ERRORS PER DIEM.

Angular motion which EACH of the Mean-time Screws are required to have to correct the Watch for TEN SECONDS per DIEM.

CHRONOMETERS. WATCHES.	Threads per Inch.	WEIGHT OF THE MEAN-TIME SCREWS IN PARTS OF THE BALANCE.												
		$\frac{1}{8}$	$\frac{1}{9}$	$\frac{1}{10}$	$\frac{1}{11}$	$\frac{1}{12}$	$\frac{1}{13}$	$\frac{1}{14}$	$\frac{1}{15}$	$\frac{1}{16}$	$\frac{1}{17}$	$\frac{1}{18}$	$\frac{1}{19}$	$\frac{1}{20}$
		°	°	°	°	°	°	°	°	°	°	°	°	°
	100	16°	17°	19°	21°	23°	25°	27°	28°	30°	32°	34°	36°	38°
	110	17	19	21	23	25	27	29	31	33	35	37	40	42
	120	19	21	23	25	27	30	32	34	36	39	41	43	46
	130	20	23	25	27	30	32	35	37	39	42	44	47	50
	140	22	24	27	30	32	35	37	40	42	45	48	50	53
	150	23	26	29	32	34	37	40	43	45	48	51	54	57
	160	25	28	31	34	37	40	43	45	48	52	55	58	61
	170	27	30	33	36	39	42	45	48	52	55	58	61	65
	180	28	31	35	38	41	44	48	51	55	58	62	65	68
	190	30	33	36	40	43	47	50	54	58	61	65	68	72
	200	31	35	38	42	46	49	53	57	61	64	68	72	76
	210	33	36	40	44	48	52	56	60	64	68	72	76	80
	220	34	38	42	46	50	54	58	62	67	71	75	79	84
	230	36	40	44	48	53	57	61	65	70	74	79	83	87
	240	38	42	46	50	55	60	64	68	73	77	82	86	91
	250	39	43	48	53	57	62	66	71	76	80	85	90	95
	260	40	45	50	55	60	64	69	74	79	84	89	94	99

TABLE G.—No. V.

COMPARATIVE POWERS OF BALANCE SPRINGS.

This Table shows what loss of time in Sec. per Min. would result from the increased diameter and weight of balance in a watch, upon a supposition that the same balance spring is applied thereto with which the watch two sizes smaller goes to time.*

C. F. MOVEMT.	BARREL.		BALANCE.		LOSS PER MIN.
Pillars of	Diam.	Height.	Diam.	Weight.	Sec.
No. VI.	50	by 13½	50	6½	0·0
VIII.	53½	"	53½	7	5·8
X.	56½	"	56½	7½	5·5
XII.	60	"	60	8	5·1
XIV.	63½	"	63	8½	4·8
XVI.	66¾	"	65	9	4·6
XVIII.	70	"	70	9½	4·4
XX.	73½	"	73	10	4·2
XXII.	76¾	"	76	10½	4·1

* The gradations of strength in balance spring wire, from number to number, is equal to about *five sec. per min.* When diameters are equal, and weights only are different, Table No. I. gives the amount of loss or gain per min. between one weight of balance and another, and consequently indicates the proper number of wire to be used: thus, a balance of 20 grs. weight would be made to lose *five sec. per min.* by the addition of 2·30 grs., and would therefore require the next number of wire. Again, if it be desired to know what additional weight would cause a balance of 10 grs. to lose *five sec. per min.*, the first column of Table I. answers the question, viz. 1·15 gr., and shows the next number of wire to be necessary.

USE OF THE TABLES.

TAB. I. Take out the numbers under the *seconds* and *tenths* in the line corresponding with the parts of the weight of the balance in the left-hand column,—their sum is the subsidary weight required.

Example.—The Chronometer No. 2412 had a balance of 77·5 grains, and lost 2″·2 per min., required the weight of the screw for its correction.

	Grs.
TAB. I.—Under 2 sec. 2 tenths against 70 are	3·22 and ·32 = 3·54
" " " 7·	·32 and ·03 = ·35
For the decimals remove one place	0·5 ·02 and ·00 = ·02
	3·91

By experiment the weight was found to be four grains, consequently the error in the above determination (less than one tenth of a grain) was within the power of the Mean-time screws.

The construction and use of TAB. II. are the same as those of No. I.; but the correctional quantities are to be taken away from the balance, instead of being added, as in Tab. I.; and in order to prevent lightening the balance too much, the correction is taken at $\frac{1}{30}$ instead of $\frac{1}{45}$.

These tables are suited to any and every train; whatever may be the weight or diameter of the balance, or the number of its vibrations. The acting influences are, however, so various, that it is impossible to do more than give a close approximation to that fractional part of the entire weight of the balance which corrects a watch for ONE TENTH OF A SECOND PER MIN.

The *correction* will sometimes lie within the range of the *mean-time screws*; for which no definite directions can be given; since the extent of that range depends not only upon the number of threads per inch in the screw itself, but also upon the *shape*, as well as the *weight*, of the masses. An approximate judgment of these effects may, however, be formed from the following experiment.—A *mean-time Chronometer*, of which the balance weighed 75 grains, and the mean-time screws together 4½* grains ($\frac{1}{17}$th of the entire weight of the balance) was converted into a *Chronometer* keeping *Sidereal time*, by turning each of the mean-time screws *five half turns* towards the centre; the screws having 120 threads to the inch: that is, it gained on mean time, 3m. 56·5*s.* in 24 hours = 9·8*s.* per hour, or 0″·16 per minute.

A similar effect would be produced in a *Watch balance* of 9 grains, of which the two mean-time screws are together half a grain ($\frac{1}{18}$th of the entire weight of the balance), provided the number of threads per inch are proportionably increased. Hence it is shown that, under certain conditions, we can, at pleasure, change a *Mean-time Chronometer* into a *Sidereal Chronometer*, and vice versa, by the operation of the mean-time screws alone.

**Dimensions of Mean-time Screws.*

2½ grs.—·140 diam. by ·105.
4 " ·147 " by ·135.
6½ " ·178 " by ·148

It is important to bear in mind that the effect of each pair of weights applied to a balance is to be estimated by their MOMENTUM;—an engineering term, used to imply *the product of their united weights multiplied by the diametral distance of their centres of gravity*;—also, that the momentum of the entire balance is made up of the sum of the moments of all its parts; each taken in the same manner.

TAB. III.—For Circular Compensation Weights, is calculated upon the supposition that the SLOT passes through the centre of the weight, so that the diametral distance of the circular weights is the same as the diameter of the balance taken at the junction of the brass and steel. Square Compensation Weights virtually follow the same laws as those of a circular form; but as variation of shape varies their centres of gravity, and the situation of the slot varies their diametral distances, it is not easy to lay down rules respecting them that would be of any practical value.

It is on account of their different distances from the centre of the balance, that circular weights placed on the edge of the rim and make-weights placed outside the rim, produce different effects on the time of the watch:—for instance, a pair of circular weights, together 8 grs., placed on the rim, caused the watch to lose 2*m.* 47*s.* per hour; whereas, two make-weight screws, together 8 grs., caused it to lose 3*m.* 7*s.* per hour.

By calculation, the addition for each second of error per minute is $\frac{1}{45}$ of the entire weight of the balance, if applied on the rim; and, by experiment, the number comes out $\frac{1}{44}$ when applied as a make-weight screw; and it is somewhat remarkable that the values of the fractions $\frac{1}{30}$ to $\frac{1}{51}$ are exactly as 3 to 2.

USE OF TABLES G.—No. III. and G.—No. IV.

Required to know the weight of a pair of Circular Compensation Weights that would bring to time a Chronometer to which a new balance spring was about to be applied.—Took off the Compensation Weights, and applied the spring, when the Chronometer gained 19 seconds per minute. The balance (including a pair of mean-time screws, together 4·6 grs.) weighed 31 grains, and by table G.—No. III. the two Circular Compensation Weights should, together, weigh $\frac{19}{44}$ of 31 grs., or $\frac{31 \times 19}{44}$ = 22 grs., which being applied, and the watch set going, it was found to gain on mean time 17 seconds per hour. The mean-time screws formed of the entire weight of the balance $\frac{2\frac{1}{2} \times 17}{4\frac{1}{2} \times 19} = \frac{1}{4\frac{1}{2}}$ and the number of threads per inch is about 180*; therefore by Table G.—No. IV, the value of one half turn of each screw is 2 seconds per hour; so that by drawing out each screw 4 half turns, the watch would be brought to mean time.

*The number of threads per inch is thus found:—The two mean-time screws driven nearly home, the outer diameter was 1·235 inches; and when each mean-time screw was drawn out 10 half turns, the outer diameter was 1·291, then say, as the difference, 56 : 1000 :: 10 turns : 180 threads nearly.

CHARLES FRODSHAM, F.R.A.S., Assoc. C.E.

(ARNOLD'S) 84, *Strand, London.*

A.D. 1853

DESCRIPTION

OF

CHARLES FRODSHAM'S REGISTER,

OR

SPLIT CENTRE SECOND'S-HAND WATCH.

THIS watch being a perfect time-keeper, is capable of determining the precise time of any observation to a quarter of a second, by means of an extra second's hand with which it is provided, and which, in the ordinary state of the watch, lies under the principal second's hand, and travels with it. In taking an observation, the observer keeps his eye steadily fixed upon the object, and his finger in readiness to touch a spring, which allows the registering hand to fall simultaneously upon the face of the watch, where it may be allowed to remain upwards of forty seconds for reading off the time, which done, the finger is to be immediately removed in order to free the register, which instantly returns to its place ready for the next observation, without having in the least degree interfered with the correct performance of the watch.

The mechanism may be adapted to a Chronometer, but it has been more generally applied to our compensated Lever Watches, which, while they rival the chronometer in the steadiness of their performance, are pronounced by several accredited wearers, to be positively unaffected by the violent exercises of riding, hunting, &c., which can hardly fail to disturb the rate, if not to injure the delicate mechanism of a chronometer.

This watch was originally intended for astronomical observations, but it has of late years been employed with advantage in determining velocities, which it does with a precision to which the keenest observer with an ordinary second's watch, cannot pretend, on account of the time lost in removing the eye from the object to the watch, and the uncertainty of correctly reading off the time with sufficient celerity. In the high velocities at the commencement of the table, the error of a single second causes an error of ten miles per hour in the velocity deduced.

Charles Frodsham

ARNOLD'S,
84, STRAND, LONDON.

COMPANION TO CHARLES FRODSHAM'S REGISTER, OR SPLIT CENTRE SECOND'S-HAND WATCH.

DIRECTIONS FOR USE.—Having ascertained the time in Seconds, of effecting either of the Quarter-mile Runs from Post to Post, which by this watch may be accurately determined to a quarter of a Second, seek this number, or the nearest thereto, in the red or time column, and even therewith you have the velocity per hour in miles and hundredths. Should it however happen that the passing of a train or other circumstance, prevents the correct noting of the intended quarter-mile run, observe the time occupied in making two, three, or four consecutive runs; then, by dividing by the number of runs, the mean velocity per hour will be found against the mean time of performing the quarter mile.

Qr.-Mile Runs in Time.	Miles per Hour.	Qr.-Mile Runs in Time.	Miles per Hour.	Qr.-Mile Runs in Time.	Miles per Hour.	Qr.-Mile Runs in Time.	Miles per Hour.
SEC.	MILES	SEC.	MILES	SEC.	MILES	SEC.	MILES
9	100.00	15	60.00	20¼	43.37	26½	33.96
9¼	97.29	15¼	59.01	21	42.86	26¾	33.64
9½	94.74	15½	58.06	21¼	42.35	27	33.33
9¾	92.30	15¾	57.14	21½	41.86	27¼	33.02
10	90.00	16	56.25	21¾	41.38	27½	32.73
10¼	87.80	16¼	55.38	22	40.91	27¾	32.43
10½	85.71	16½	54.54	22¼	40.45	28	32.14
10¾	83.72	16¾	53.73	22½	40.00	28¼	31.86
11	81.82	17	52.94	22¾	39.56	28½	31.58
11¼	80.00	17¼	52.17	23	39.13	28¾	31.30
11½	78.26	17½	51.43	23¼	38.70	29	31.03
11¾	76.59	17¾	50.70	23½	38.30	29¼	30.77
12	75.00	18	50.00	23¾	37.89	29½	30.51
12¼	73.47	18¼	49.31	24	37.50	29¾	30.25
12½	72.00	18½	48.65	24¼	37.11	30	30.00
12¾	70.59	18¾	48.00	24½	36.73	30½	29.50
13	69.23	19	47.37	24¾	36.36	31	29.03
13¼	67.92	19¼	46.74	25	36.00	31½	28.57
13½	66.67	19½	46.15	25¼	35.64	32	28.12
13¾	65.45	19¾	45.57	25½	35.29	32½	27.69
14	64.28	20	45.00	25¾	34 95	33	27.27
14¼	63.16	20¼	44.44	26	34.61	33½	26.86
14½	62.07	20½	43.90	26¼	34.28	34	26.47
14¾	61.02						

Qr.-Mile Runs in Time.	Miles per Hour.	Qr.-Mile Runs in Time.	Miles per Hour.	Qr.-Mile Runs in Time.	Miles per Hour.	Qr.-Mile Runs in Time.	Miles per Hour.
SEC.	MILES	SEC.	MILES	SEC.	MILES	SEC.	MILES
34½	26.08	46	19.56	57½	15.65	78	11.54
35	25.71	46½	19.35	58	15.51	79	11.39
35½	25.35	47	19.15	58½	15.38	80	11.25
36	25.00	47½	18.94	59	15.25	81	11.11
36½	24.65	48	18.75	59½	15.12	82	10.97
37	24.32	48½	18.55	60	15.00	83	10.84
37½	24.00	49	18.36	61	14.75	84	10.71
38	23.68	49½	18.18	62	14.51	85	10.59
38½	23.37	50	18.00	63	14.28	86	10.46
39	23.07	50½	17.82	64	14.06	87	10.34
39½	22.78	51	17.64	65	13.84	88	10.22
40	22.50	51½	17.47	66	13.63	89	10.11
40½	22.22	52	17.30	67	13.43	90	10.00
41	21.95	52½	17.14	68	13.23	91	9.89
41½	21.68	53	16.98	69	13.04	92	9.78
42	21.43	53½	16.82	70	12.85	93	9.67
42½	21.17	54	16.66	71	12.67	94	9.57
43	20.93	54½	16.51	72	12.50	95	9.47
43½	20.69	55	16.36	73	12.32	96	9.37
44	20.45	55½	16.21	74	12.16	97	9.27
44½	20.22	56	16.07	75	12.00	98	9.18
45	20.00	56½	15.93	76	11.84	99	9.09
45½	19.78	57	15.79	77	11.69	100	9.00

N. B. The construction of this table is exceedingly simple, the numbers in the column of velocities being merely the quotients resulting from a division of numbers in the time column into the constant number 900, the seconds in a quarter of an hour.

This table is equally applicable to the French and some other continental lines, where the distances are estimated by the kilomètre, equal to 5 English furlongs, and 4 kilomètres or 20 furlongs, equal to the French league, or 2½ English miles. If, for instance, the kilomètres per hour be desired, enter the table with ¼ the number of seconds in running the kilomètre; if in French leagues, enter with the time of running the whole kilomètre; but if the hourly velocity be desired in English miles, enter the table with one fifth of double the time of the kilomètre run.

COMPARATIVE TABLE

Shewing equivalents in sizes of WATCH GLASSES by 1/10 m/m, 1/16, 1/8 and 1/4 Systems.

	m/m gauge.	158	159	160	161	162	163	164	165	166	167	168
	1/16th	7	7 1/16	7 2/16	7 2/16	7 3/16	7 4/16	7 4/16	7 5/16	7 6/16	7 7/16	7 7/16
	1/8th	7/0	7/0 1/8	7/0 2/8	7/0 2/8	7/0 3/8	7/0 4/8	7/0 4/8	7/0 5/8	7/0 6/8	7/0 7/8	7/0 7/8
	m m gauge	169	170	171	172	173	174	175	176	177	178	179
A.	1/16th	7 8/16	7 9/16	7 9/16	7 10/16	7 11/16	7 11/16	7 12/16	7 13/16	7 14/16	7 14/16	7 15/16
B.	1/8th	6/0	6/0 1/8	6/0 1/8	6/0 2/8	6/0 3/8	6/0 3/8	6/0 4/8	6/0 5/8	6/0 6/8	6/0 6/8	6/0 7/8
C.	1/4th		12/0			12/0 1/4		12/0 1/2		12/0 3/4		11/0
	m/m gauge	180	181	182	183	184	185	186	187	188	189	190
	1/16th	8	8 1/16	8 1/16	8 2/16	8 3/16	8 3/16	8 4/16	8 5/16	8 5/16	8 6/16	8 7/16
	1/8th	5/0	5/0 1/8	5/0 1/8	5/0 2/8	5/0 3/8	5/0 3/8	5/0 4/8	5/0 5/8	5/0 5/8	5/0 6/8	5/0 7/8
	1/4th		11/0 1/4		11/0 1/2			11/0 3/4		10/0		10/0 1/4
	m/m gauge	191	192	193	194	195	196	197	198	199	200	201
	1/16th	8 8/16	8 8/16	8 9/16	8 10/16	8 10/16	8 11/16	8 12/16	8 13/16	8 13/16	8 14/16	8 15/16
	1/8th	4/0	4/0	4/0 1/8	4/0 2/8	4/0 2/8	4/0 3/8	4/0 4/8	4/0 5/8	4/0 5/8	4/0 6/8	4/0 7/8
	1/4th		10/0 1/2		10/0 3/4		9/0		9/0 1/4		9/0 1/2	

m/m gauge	202	203	204	205	206	207	208	209	210	211	212
1/16th	8 15/16	9	9 1/16	9 2/16	9 2/16	9 3/16	9 4/16	9 4/16	9 5/16	9 6/16	9 7/16
1/8th	4/0 7/8	3/0	3/0 1/8	3/0 2/8	3/0 2/8	3/0 3/8	3/0 4/8	3/0 4/8	3/0 5/8	3/0 6/8	3/0 7/8
1/4th		9/0 3/4		8/0		8/0 1/4		8/0 1/2		8/0 3/4	
m/m gauge	213	214	215	216	217	218	219	220	221	222	223
1/16th	9 7/16	9 8/16	9 9/16	9 9/16	9 10/16	9 11/16	9 11/16	9 12/16	9 13/16	9 14/16	9 14/16
1/8th	3/0 7/8	2/0	2/0 1/8	2/0 1/8	2/0 2/8	2/0 3/8	2/0 3/8	2/0 4/8	2/0 5/8	2/0 6/8	2/0 6/8
1/4th	7/0		7/0 1/4		7/0 1/2			7/0 3/4		6/0	
m/m gauge	224	225	226	227	228	229	230	231	232	233	234
1/16th	9 15/16	10	10	10 1/16	10 2/16	10 3/16	10 3/16	10 4/16	10 5/16	10 5/16	10 6/16
1/8th	2/0 7/8	0	0	0 1/8	0 2/8	0 3/8	0 3/8	0 4/8	0 5/8	0 5/8	0 6/8
1/4th	6/0 1/4		6/0 1/2		6/0 3/4		5/0		5/0 1/4		5/0 1/2
m/m gauge	235	236	237	238	239	240	241	242	243	244	245
1/16th	10 7/16	10 8/16	10 8/16	10 9/16	10 10/16	10 10/16	10 11/16	10 12/16	10 12/16	10 13/16	10 14/16
1/8th	0 7/8	1	1	1 1/8	1 2/8	1 2/8	1 3/8	1 4/8	1 4/8	1 5/8	1 6/8
1/4th		5/0 3/4		4/0			4/0 1/4		4/0 1/2		4/0 3/4
m/m gauge	246	247	248	249	250	251	252	253	254	255	256
1/16th	10 15/16	10 15/16	11	11 1/16	11 1/16	11 2/16	11 3/16	11 4/16	11 4/16	11 5/16	11 6/16
1/8th	1 7/8	1 7/8	2	2 1/8	2 1/8	2 2/8	2 3/8	2 4/8	2 4/8	2 5/8	2 6/8
1/4th		3/0		3/0 1/4		3/0 1/2		3/0 3/4		2/0	

m/m gauge	257	258	259	260	261	262	263	264	265	266	267
1/16th	11 6 16	11 7/16	11 8 16	11 9/16	11 9 16	11 1 16	11 11 16	11 11/16	11 12/16	11 13/16	11 14/16
1/8th	2 6 8	2 7 8	3	3 1 8	3 1 8	3 2 8	3 3 8	3 3/8	3 4/8	3 5/8	3 6/8
1/4th	2/0 1/4		2 0 1 2			2 0 3/4		0		0 1/4	0 1/2

m/m gauge	268	269
1/16th	11 14/16	11 15/16
1/8th	3 6/8	3 7/8
1/4th		0 3/4

m/m gauge	270	271	272	273	274	275	276	277	278	279	280
1/16th	12	12	12 1 16	12 2 16	12 2 16	12 3 16	12 4/16	12 5/16	12 5/16	12 6/16	12 7/16
1/8th	4	4	4 1 8	4 2 8	4 2 8	4 3 8	4 4 8	4 5 8	4 5/8	4 6/8	4 7/8
1/4th		1		1 1 4		1 1 2		1 3/4		2	

m/m gauge	281	282	283	284	285	286	287	288	289	290	291
1/16th	12 7/16	12 8/16	12 9/16	12 10/16	12 10 16	12 11 16	12 12/16	12 12/16	12 13/16	12 14/16	12 15/16
1/8th	4 7/8	5	5 1/8	5 2 8	5 2 8	5 3 8	5 4/8	5 4/8	5 5/8	5 6/8	5 7/8
1/4th	2 1/4		2 1/2		2 3/4		3		3 1/4		3 1/2

m/m gauge	292	293	294	295	296	297	298	299	300	301	302
1/16th	12 15/16	13	13 1/16	13 1 16	13 2 16	13 3 16	13 4 16	13 4/16	13 5/16	13 6/16	13 6/16
1/8th	5 7/8	6	6 1/8	6 1 8	6 2 8	6 3 8	6 4 8	6 4 8	6 5/8	6 6/8	6 6/8
1/4th		3 3/4			4		4 1/4			4 1/2	

m/m gauge	303	304	305	306	307	308	309	310	311	312	313
1/16th	13 7/16	13 8/16	13 8/16	13 9/16	13 10/16	13 11/16	13 11/16	13 12/16	13 13/16	13 13/16	13 14/16
1/8th	6 7/8	7	7	7 1/8	7 2/8	7 3/8	7 3/8	7 4/8	7 5/8	7 5/8	7 6/8
1/4th	4 3/4		5		5 1/4			5 1/2		5 3/4	
m/m gauge	314	315	316	317	318	319	320	321	322	323	324
1/16th	13 15/16	14	14	14 1/16	14 2/16	14 3/16	14 3/16	14 4/16	14 5/16	14 5/16	14 6/16
1/8th	7 7/8	8	8	8 1/8	8 2/8	8 3/8	8 3/8	8 4/8	8 5/8	8 5/8	8 6/8
1/4th	6		6 1/4		6 1/2		6 3/4		7		7 1/4
m/m gauge	325	326	327	328	329	330	331	332	333	334	335
1/16th	14 7/16	14 7/16	14 8/16	14 9/16	14 9/16	14 10/16	14 11/16	14 12/16	14 12/16	14 13/16	14 14/16
1/8th	8 7/8	8 7/8	9	9 1/8	9 1/8	9 2/8	9 3/8	9 4/8	9 4/8	9 5/8	9 6/8
1/4th			7 1/2		7 3/4		8		8 1/4		8 1/2
m/m gauge	336	337	338	339	340	341	342	343	344	345	346
1/16th	14 14/16	14 15/16	15	15 1/16	15 1/16	15 2/16	15 3/16	15 3/16	15 4/16	15 5/16	15 6/16
1/8th	9 6/8	9 7/8	10	10 1/8	10 1/8	10 2/8	10 3/8	10 3/8	10 4/8	10 5/8	10 6/8
1/4th		8 3/4		9		9 1/4		9 1/2		9 3/4	
m/m gauge	347	348	349	350	351	352	353	354	355	356	357
1/16th	15 6/16	15 7/16	15 8/16	15 8/16	15 9/16	15 10/16	15 11/16	15 11/16	15 12/16	15 13/16	15 13/16
1/8th	10 6/8	10 7/8	11	11	11 1/8	11 2/8	11 3/8	11 3/8	11 4/8	11 5/8	11 5/8
1/4th		10			10 1/4		10 1/2		10 3/4		11

m/m gauge	358	359	360	361	362	363	364	365	366	367	368
1/16th	15 14/16	15 15/16	15 15/16	16	16 1/16	16 2/16	16 2/16	16 3/16	16 4/16	16 4/16	16 5/16
1/8th	11 6/8	11 7/8	11 7/8	12	12 1/8	12 2/8	12 2/8	12 3/8	12 4/8	12 4/8	12 5/8
1/4th		11 1/4		11 1/2		11 3/4		12			12 1/4
m/m gauge	369	370	371	372	373	374	375	376	377	378	379
1/16th	16 6/16	16 7/16	16 7/16	16 8/16	16 9/16	16 9/16	16 10/16	16 11/16	16 12/16	16 12/16	16 13/16
1/8th	12 6/8	12 7/8	12 7/8	13	13 1/8	13 1/8	13 2/8	13 3/8	13 4/8	13 4/8	13 5/8
1/4th		12 1/2		12 3/4		13		13 1/4			13 1/2
m/m gauge	380	381	382	383	384	385	386	387	388	389	390
1/16th	16 14/16	16 14/16	16 15/16	17	17 1/16	17 1/16	17 2/16	17 3/16	17 3/16	17 4/16	17 5/16
1/8th	13 6/8	13 6/8	13 7/8	14	14 1/8	14 1/8	14 2/8	14 3/8	14 3/8	14 4/8	14 5/8
1/4th		13 3/4		14		14 1/4		14 1/2		14 3/4	
m/m gauge	391	392	393	394	395	396	397	398	399	400	401
1/16th	17 5/16	17 6/16	17 7/16	17 8/16	17 8/16	17 9/16	17 10/16	17 10/16	17 11/16	17 12/16	17 13/16
1/8th	14 5/8	14 6/8	14 7/8	15	15	15 1/8	15 2/8	15 2/8	15 3/8	15 4/8	15 5/8
1/4th	15		15 1/4		15 1/2		15 3/4			16	
m/m gauge	402	403	404	405	406	407	408	409	410	411	412
1/16th	17 13/6	17 14/16	17 15/16	17 15/16	18	18 1/16	18 2/16	18 2/16	18 3/16	18 4/16	18 4/16
1/8th	15 5/8	15 6/8	15 7/8	15 7/8	16	16 1/8	16 2/8	16 2/8	16 3/8	16 4/8	16 4/8
1/4th	16 1/4		16 1/2		16 3/4		17			17 1/4	

m/m gauge	413	414	415	416	417	418	419	420	421	422	423
1/16th	18 5/16	18 6/16	18 6/16	18 7/16	18 8/16	18 9/16	18 9/16	18 10/16	18 11/16	18 11/16	18 12/16
1/8th	16 5/8	16 6/8	16 6/8	16 7/8	17	17 1/8	17 1/8	17 2/8	17 3/8	17 3/8	17 4/8
1/4th	17 1/2		17 3/4		18		18 1/4		18 1/2		18 3/4
m/m gauge	424	425	426	427	428	429	430	431	432	433	434
1/16th	18 13/16	18 14/16	18 14 16	18 15/16	19	19	19 1/16	19 2/16	19 3/16	19 3/16	19 4/16
1/8th	17 5/8	17 6/8	17 6/8	17 7/8	18	18	18 1/8	18 2/8	18 3/8	18 3/8	18 4/8
1/4th			19		19 1/4		19 1/2		19 3/4		20
m/m gauge	435	436	437	438	439	440	441	442	443	444	445
1/16th	19 5/16	19 5/16	19 6/16	19 7/16	19 8/16	19 8/16	19 9/16	19 10/16	19 10/16	19 11/16	19 12/16
1/8th	18 5/8	18 5/8	18 6/8	18 7/8	19	19	19 1/8	19 2/8	19 2/8	19 3/8	19 4/8
1/4th		20 1/4		20 1/2			20 3/4			21	
m/m gauge	446	447	448	449	450	451	452	453	454	455	456
1/16th	19 12/16	19 13/16	19 14/16	19 15/16	19 15/16	20	20 1/16	20 1/16	20 2/16	20 3/16	20 4/16
1/8th	19 4/8	19 5/8	19 6/8	19 7/8	19 7/8	20	20 1/8	20 1/8	20 2/8	20 3/8	20 4/8
1/4th	21 1/4		21 1/2		21 3/4		22		22 1/4		22 1/2
m/m gauge	457	458	459	460	461	462	463	464	465	466	467
1/16th	20 4/16	20 5/16	20 6/16	20 6/16	20 7/16	20 8/16	20 9/16	20 9/16	20 10/16	20 11/16	20 11/16
1/8th	20 4/8	20 5/8	20 6/8	20 6/8	20 7/8	21	21 1/8	21 1/8	21 2/8	21 3/8	21 3/8
1/4th		22 3/4		23		23 1/4		23 1/2		23 3/4	

m/m gauge	468	469	470	471	472	473	474	475	476	477	478
1/16th	20 12/16	20 13/16	20 14/16	20 14/16	20 15/16	21	21	21 1/16	21 2/16	21 2/16	21 3/16
1/8th	21 4/8	21 5/8	21 6/8	21 6/8	21 7/8	22	22	22 1/8	22 2/8	22 2/8	22 3/8
1/4th	24		24 1/4		24 1/2			24 3/4		25	
m/m gauge	479	480	481	482	483	484	485	486	487	488	489
1/16th	21 4/16	21 5/16	21 5/16	21 6/16	21 7/16	21 7/16	21 8/16	21 9/16	21 10/16	21 10/16	21 11/16
1/8th	22 4/8	22 5/8	22 5/8	22 6/8	22 7/8	22 7/8	23	23 1/8	23 2/8	23 2/8	23 3/8
1/4th	25 1/4		25 1/2		25 3/4		26		26 1/4		26 1/2
m/m gauge	490	491	492	493	494	495	496	497	498	499	500
1/16th	21 12/16	21 12/16	21 13/16	21 14/16	21 15/16	21 15/16	22	22 1/16	22 1/16	22 2/16	22 3/16
1/8th	23 4/8	23 4/8	23 5/8	23 6/8	23 7/8	23 7/8	24	24 1/8	24 1/8	24 2/8	24 3/8
1/4th			26 3/4		27			27 1/4		27 1/2	
m/m gauge	501	502	503	504	505	506	507	508	509	510	511
1/16th	22 3/16	22 4/16	22 5/16	22 6/16	22 6/16	22 7/16	22 8/16	22 8/16	22 9/16	22 10/16	22 11/16
1/8th	24 3/8	24 4/8	24 5/8	24 6/8	24 6/8	24 7/8	25	25	25 1/8	25 2/8	25 3/8
1/4th	27 3/4		28		28 1/4		28 1/2		28 3/4		29
m/m gauge	512	513	514	515	516	517	518	519	520	521	
1/16th	22 11/16	22 12/16	22 13/16	22 13/16	22 14/16	22 15/16	23	23	23 1/16	23 2/16	
1/8th	25 3/8	25 4/8	25 5/8	25 5/8	25 6/8	25 7/8	26	26	26 1/8	26 2/8	
1/4th		29 1/4		29 1/2		29 3/4					

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	Aug.	1860	163 - 164
	Oct.	1860	18 - 21
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	Jan.	1869	
G. W. Frodsham. *Outil aux Douzièmes.*	Nov.	1872	25 - 26
	May	1873	111 - 112
Parkinson & Frodsham. *Breaking of Main Springs.*	Oct.	1877	24 - 25
Winnerl Balance.	Nov.	1877	32 - 35
			40 - 41
Harrison Mill Frodsham. *Résumé of Remontoires.*	Oct.	1877	21 - 23
	Dec.	1877	49 - 53
	Jan.	1878	64 - 67
	Feb.	1878	76 - 79
	March	1878	86 - 88
	April	1878	104 - 105
	May	1878	120 - 122
	June	1878	130 - 131
	Aug.	1878	163 - 165
	Jan.	1879	58 - 59
	Feb.	1879	75
Harrison Mill Frodsham. *Breguet's Synchronizer.*	June	1878	132 - 133
Frodsham's Trochilic Escapement.	Nov.	1885	43
A. E. Rutherford. *Invention of the Compensation Balance.*	Nov.	1885	47
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Harrison Mill Frodsham's Remontoire.	June	1886	146 - 147
Nicole Nielsen & Co.'s Watch Factory.	June	1889	145 - 146
The British Watch and Clock Making Company.	May	1890	145
John Wycherley. Obituary.	Oct.	1891	17 - 19
Hutton No. 138 and Frodsham No. 2074.	May	1893	137

	Date		Pages
Nicole Nielsen. *Time of Flight Watch.*	June	1894	150
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Ship's Bell Clock.	July	1951	465
Philip Clowes's Will.	March	1952	172
Camera Timer.	Jan.	1954	32
Ship's Bell Clock.	March	1955	181
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Marine Chronometer Rating at Kew.	Aug.	1886	187
	Dec.	1886	63 - 64
Watch Trials at Kew.	Jan.	1887	74 - 75
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	May	1928	170 - 172
	June	1928	190 - 191
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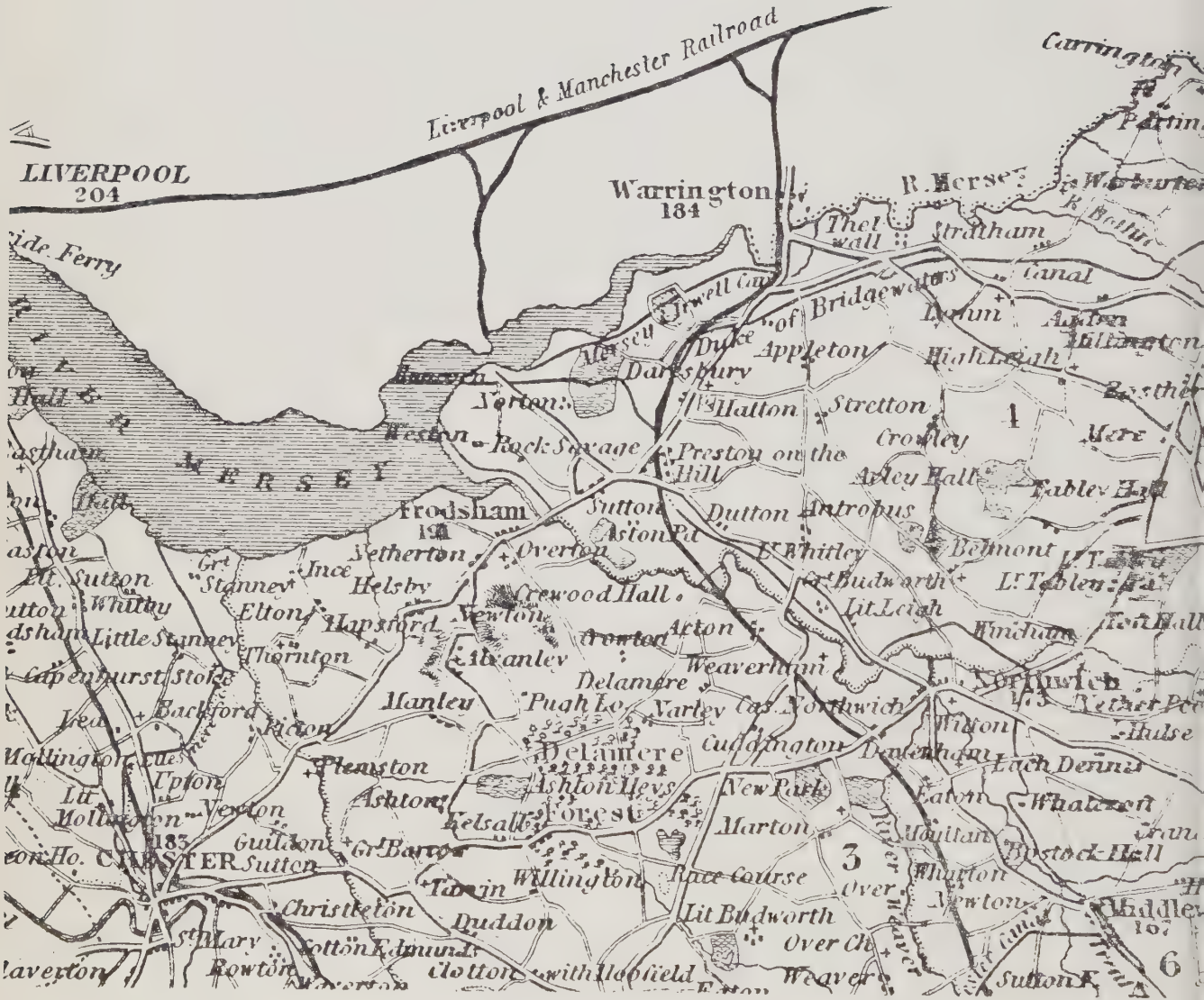
LIST OF ILLUSTRATIONS

			Page
Frontispiece		Charles Frodsham.	
Plate	1.	Map of Cheshire.	344
	2.	Map of London to show Red Lion Square, etc.	345
	3.	Frodsham, Gracechurch St., Pocket watch No. 6019. ...	346
	4.	Map of British North America.	347
	5.	William James Frodsham.	348
	6.	Parkinson and Frodsham balances.	349
	7.	William James Frodsham's balance.	350
	8.	Parkinson and Frodsham. Night-watchman's clock. ...	351
	9.	Parkinson and Frodsham. Night-watchman's clock. ...	352
	10.	Parkinson and Frodsham. Pocket chronometer No. 307.	353
	11.	Parkinson and Frodsham. Pocket chronometer No. 478.	353
	12.	Parkinson and Frodsham. Pocket chronometer No. 510.	354
	13.	Parkinson and Frodsham. Pocket chronometer No. 4608. British Museum.	354
	14.	Frodsham and Son, Gracechurch St. Pocket chronometer No. 6950. B.M.	354
	15.	Parkinson and Frodsham. Minute repeating clock watch No. 7269.	355
	16.	Henry Frodsham.	356
	17.	Frances Louisa Frodsham.	357
	18.	Henry Frodsham, London. Deck watch No. 46267. ...	358
	19.	Henry Frodsham, London. Deck watch No. 46267. ...	359
	20.	Henry Herbert Frodsham.	360
	21.	Parkinson and Frodsham, 5 Budge Row. After the bombing in 1944.	361
	22.	The *Nautical Magazine* advertisement.	362
	22a.	Clarification of this advertisement.	363
	23.	Charles Frodsham. Marine chronometer, No. 1614. ...	364
	24.	Charles Frodsham. Marine chronometer, No. 1724. ...	365
	25.	84 The Strand. In about 1838.	366
	25a.	84 The Strand. In about 1880.	367
	26.	Charles Frodsham's letter to Airy, 14.11.1843. The new balance.	368
	27.	The Frodsham-Arnold balance and the Winnerl type.	369
	28.	Charles Frodsham. Marine No. 3311. The Frodsham-Hartnup balance.	370
	29.	Charles Frodsham. Marine No. 4006. The double balance.	371
	30.	James Ferguson Cole's double rotary escapement.	372
	31.	Charles Frodsham.	373
	32.	Watch Movement Gauges.	374

33.	Pillar Gauges and Watch Glass Gauges.	375
34.	A Line Gauge.	376
35.	Lancashire Watch Glass Gauge.	377
36.	Lancashire Watch Glass Gauge.	378
37.	Charles Frodsham's Mercurial Pendulum.	379
38.	C. M. Frodsham. Marine chronometer No. 3/3308. ...	380
39.	Balances. C. M. Frodsham No. 3/3308, Parkinson and Frodsham Nos. 2441 and 4530.	381
40.	Harrison Mill Frodsham's Patent No. 191.	382
41.	Harrison Mill Frodsham's Patent No. 191.	383
42.	Harrison Mill Frodsham's Patent No. 191.	384
43.	Harrison Mill Frodsham's Remontoire.	385
44.	115 New Bond Street.	386
45.	Advertisements from the past. The Frodsham Speedometer	387
46.	Advertisements from the past. Speedometers and Watches.	388
47.	Advertisements from the past. The Frodsham watch. ...	389
48.	Advertisements from the past. An 'Upside Down' and a 'Sedan Chair' Clock	390
49.	H. J. Furneaux's Patent No. 4189.	391
50.	Charles Frodsham and Co. Ltr. Reproduction Clocks. The Markham, The Tregent, The Tompion and The Colley. ...	392
50a	Another version of 'The Tompion'.	393
51.	The Cumming, The Murray, The Cole and The Breguet. ...	394
52.	The Ellicott, The Grant, The McCabe and The Emery. ...	395
53.	The Chippendale, The Princess, The Viennese and The Peckover and The Frodsham, together with The Quare and The Gould grandmother clocks.	396
54.	The Movements used in the Reproduction Clocks. ...	397
55.	The Ship's Bell Clock.	398
56.	The Camera Timer.	399
57.	Charles Frodsham. Turret Clock at Blue Mills, Witham, Essex.	400
58.	Charles Frodsham. Carriage Clock No. 1089.	401
59.	Charles Frodsham. Carriage Clocks Nos 20766 and 2479.	402
60.	Charles Frodsham. Small Mantel Clock No. 2469. ...	403
61.	Frodsham Mantel Clocks.	404
62.	Charles Frodsham Carriage Clock No. 1560. Frodsham balance.	405
63.	Charles Frodsham balance as used in Marine Chronometers Nos. 3593 and 3597.	405
64.	The Trade Sign.	406
65.	Albert Ernest Rutherford.	407
66.	Robert Benson North.	407
67.	Philip Clowes.	407

68. 173 Brompton Road 408
69. 173 Brompton Road. 409
70. 173 Brompton Road. The Opening Ceremony. 410
71. Charles Frodsham No. 8645. Spring detent. Duo-in-uno. British Museum. 411
72. Charles Frodsham No. 01316. Independant Centre-seconds. British Museum. 411
73. Charles Frodsham No. 01191. Capped full plate lever. British Museum. 411
74. Arnold, Charles Frodsham No. 03230. Independent Centre-seconds. British Museum 411
75. Charles Frodsham No. 01380. Spring detent. Fixed winder. British Museum 412
76. Charles Frodsham No. 03503. Spring detent. Duo-in-uno. British Museum 412
77. Charles Frodsham No. 06398. 8-day lever. British Museum 412
78. Charles Frodsham No. 03529. Reversed fusee. "fecit 1868" 413
79. Charles Frodsham No. 07364. Lady's watch 413
80. Charles Frodsham No. 010161. Hanging barrel 413
81. Charles Frodsham No. 02418. Minute repeater. Micrometer regulator. British Museum 414
82. Charles Frodsham No. 02418. Minute repeater. Micrometer regulator. British Museum 414
83. Charles Frodsham. No number. Perpetual calendar Minute rep. Chronograph 414
84. Charles Frodsham No. 07820. Chronograph 415
85. Charles Frodsham No. 02317. Centre-seconds. British Museum 416
86. Charles Frodsham No. 03520. Double balance-spring. Reversed fusee. 416
87. Charles Frodsham No. 10092. Brompton Road H.M. 1947. Unfinished 416
88. Charles Frodsham No. 08157. Minute repeating clock-watch 417
89. Charles Frodsham No. 09190. Six-minute tourbillon ... 418
90. Charles Frodsham No. 09572. One-minute tourbillon and complications 420
91. Charles Frodsham No. 09572. One-minute tourbillon and complications 420
92. Time of Flight Instrument 421
93. Breguet Tourbillons 422
94. Andrew Taylor's Patent No. 16,623 423
95. Andrew Taylor and R. B. North. Simplified diagrams ... 424
96. R. B. North's Patent No. 6737 425

97. Joseph Burtin's Patent No. 7888 426
98. J. Burtin and B. Bonniksen. Simplified diagrams 427
99. B. Bonniksen's Patent No. 21,421 428
100. Bonniksen Centre Seconds and Bonniksen 'Tourbillon' ... 429
101. Bonniksen Centre Seconds and Bonniksen 'Tourbillon'. Simplified diagrams 430
102. W. and E. A. Holland, Patent No. 20,235 431
103. W. H. Douglas. Patent No. 6858 432
104. W. H. Douglas and W. and E. A. Holland. Simplified diagrams 433
105. Charles Frodsham and Co. Ltd. Standard Corinthian fusee striking and repeating model. In production, 1980 ... 434
106. Charles Frodsham and Co. Ltd. The silver clock for the Queen Mother's 80th birthday. In production, 1980 ... 435


Liverpool & Manchester Railroad
LIVERPOOL
204
Warrington
184
R. Mersey
Stratham
Canal
Bridgewaters
Duke
Appleton
Darlesbury
Halton
Stretton
Crowley
Rock Savage
Preston on the Hill
Arley Hall
Frodsham
Sutton
Dutton
Antrobus
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Whitley
Belmont
Budworth
Lit Leigh
Helsby
Overton
Crewood Hall
Hapsford
Arton
Thornton
Weaverham
Delamere
Manley
Pugh Lo
Varley
Northwich
Cuddington
Plemston
Ashton Heys
Forest
New Park
Marton
Eaton
Whatcroft
Guilton
Gr Barrow
Helsall
Willington
Race Course
Lit Budworth
Over
Christleton
Duddon
St Mary
Rowton
Sutton
Weaver
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Ferry
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Rock Savage
Preston on the Hill
Arley Hall
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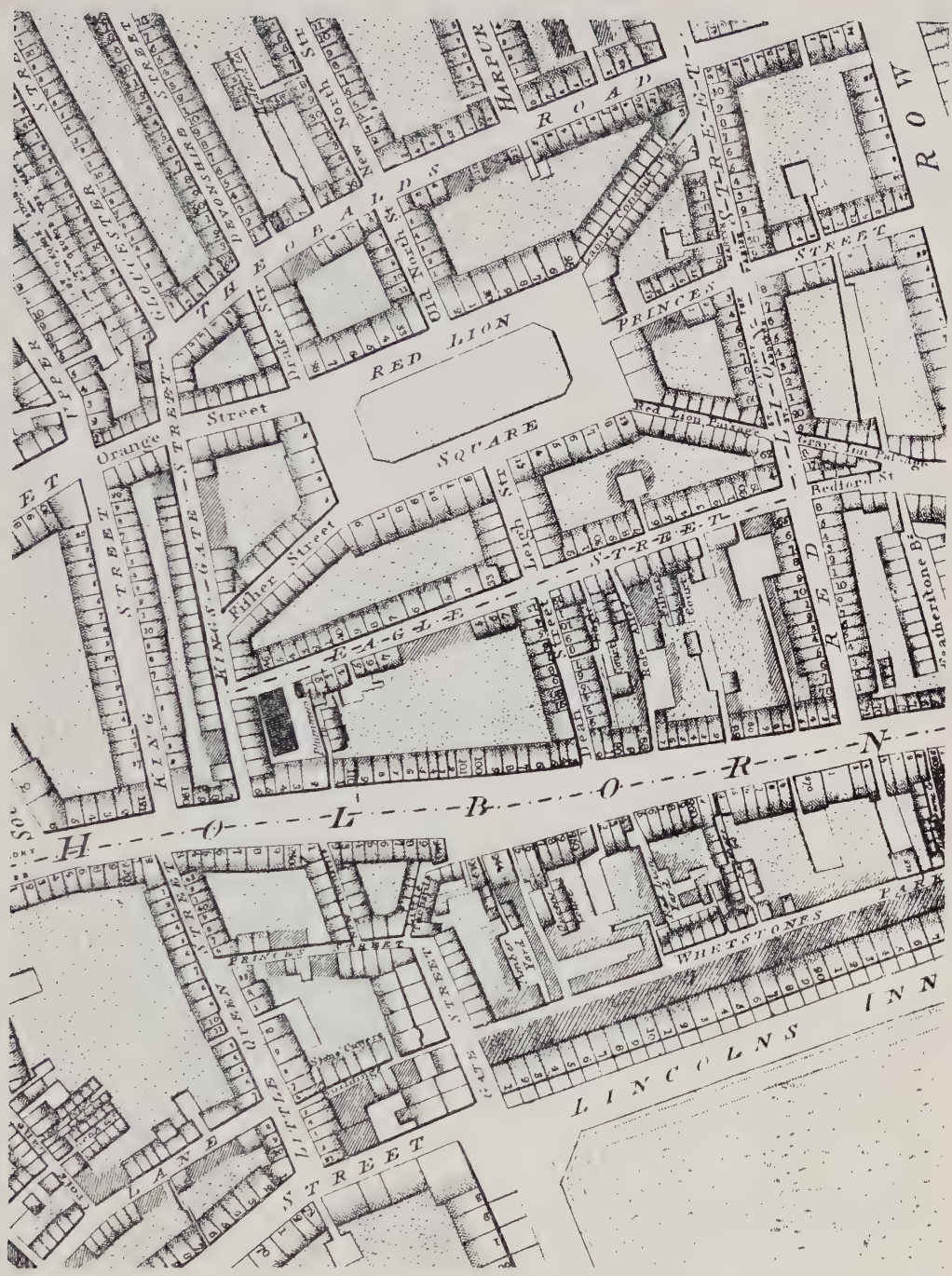
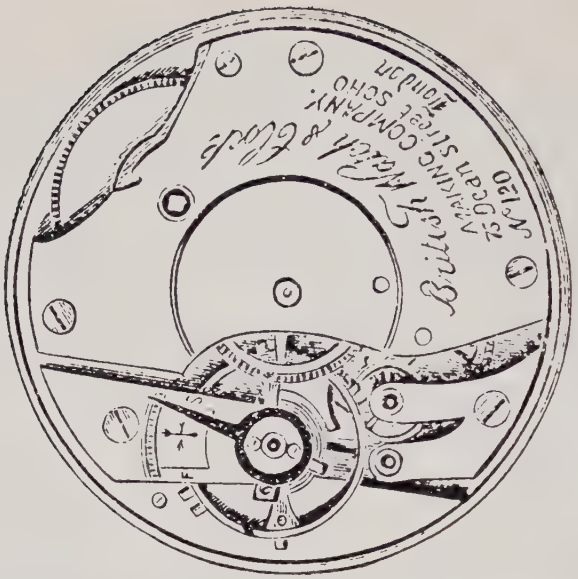


PLATE 2.

Map of London to show Red Lion Square, Kingsgate Street and Holborn.

Horwood, 1792. Reproduced from the copy in Guildhall Library, by the courtesy of the Librarian.



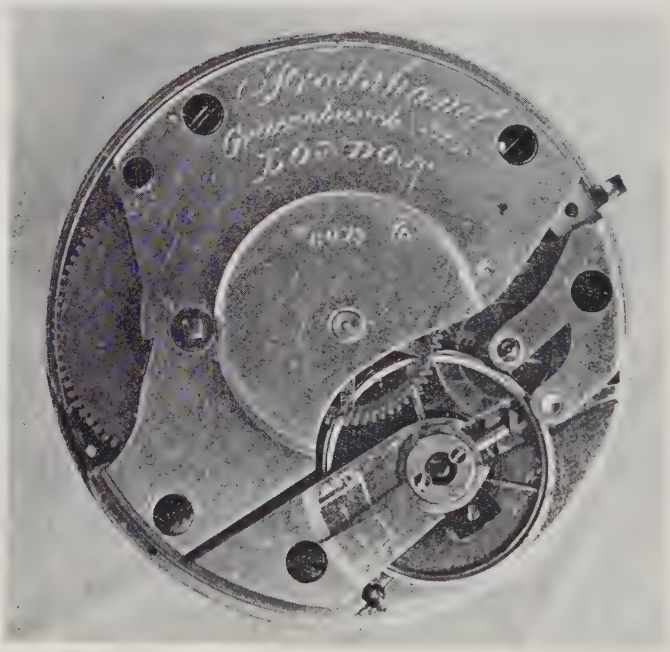


PLATE 3.

Frodsham, Gracechurch Street, London. No. 6019; this type of watch was made by "The British Watch and Clock Making Company of 75 Dean Street, Soho". Note the raised-up central portion of the plate to take the centre wheel, thereby allowing the rest of the movement to be thinner. The plate is cut out to take the click for the stop work which is situated on the top of the going barrel. See page 712 of *Antiquarian Horology* for 1978.

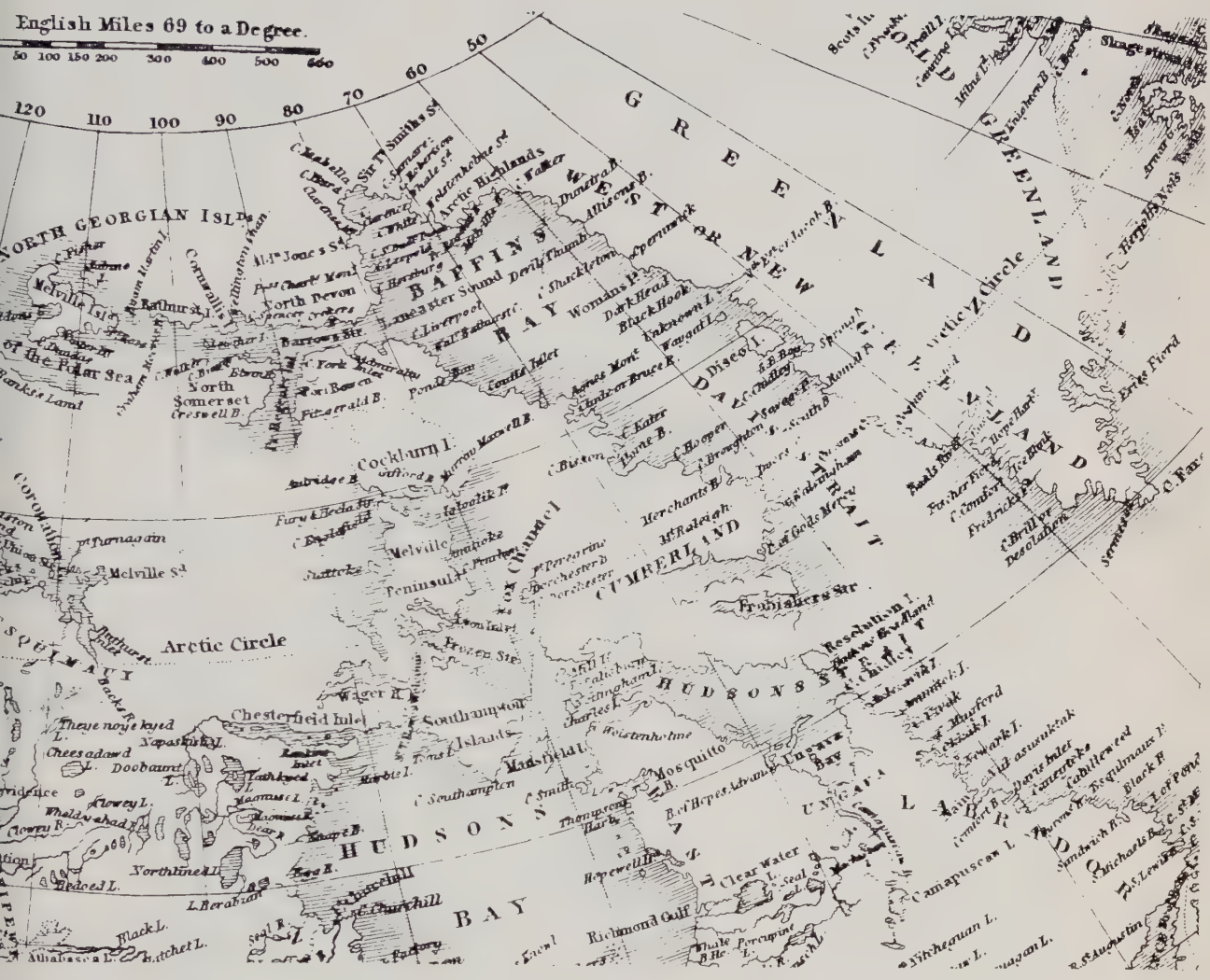


PLATE 4.

Map of British North America to illustrate the voyages made in search of a North-West passage.

From Bell's *System of Geography*, 1840.

PLATE 5.

William James Frodsham, F.R.S.

Engraving by Ada Cole from a painting.

By the courtesy of Guildhall Library, City of London.

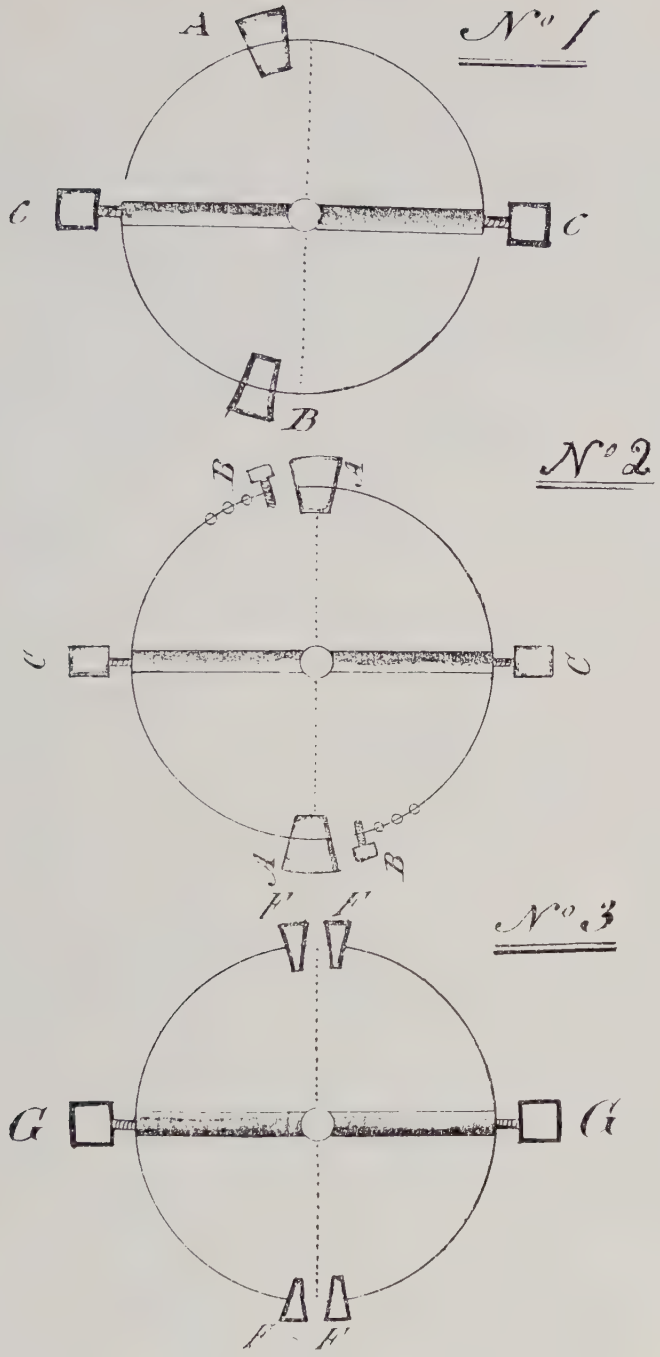
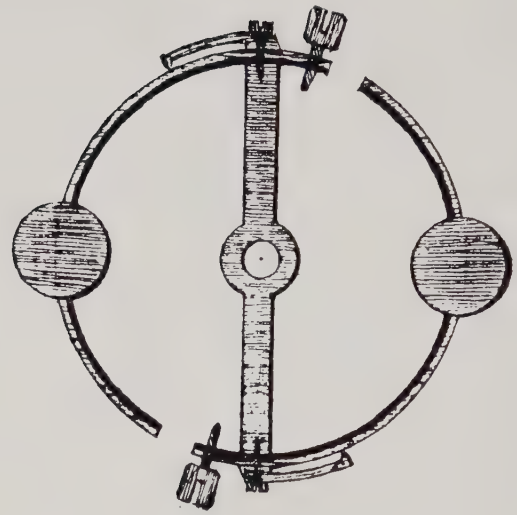


PLATE 6.

Parkinson & Frodsham balances.

1. The normal balance. 2. A quadrant balance. 3. A four quadrant balance.



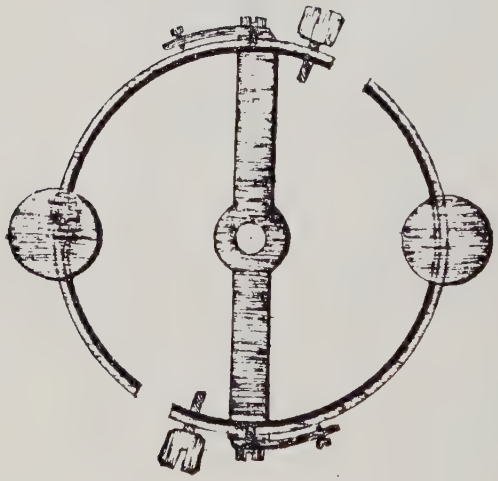


PLATE 7.

William James Frodsham's balance.

Above : August 11th, 1842.

Below : August 12th, 1842.

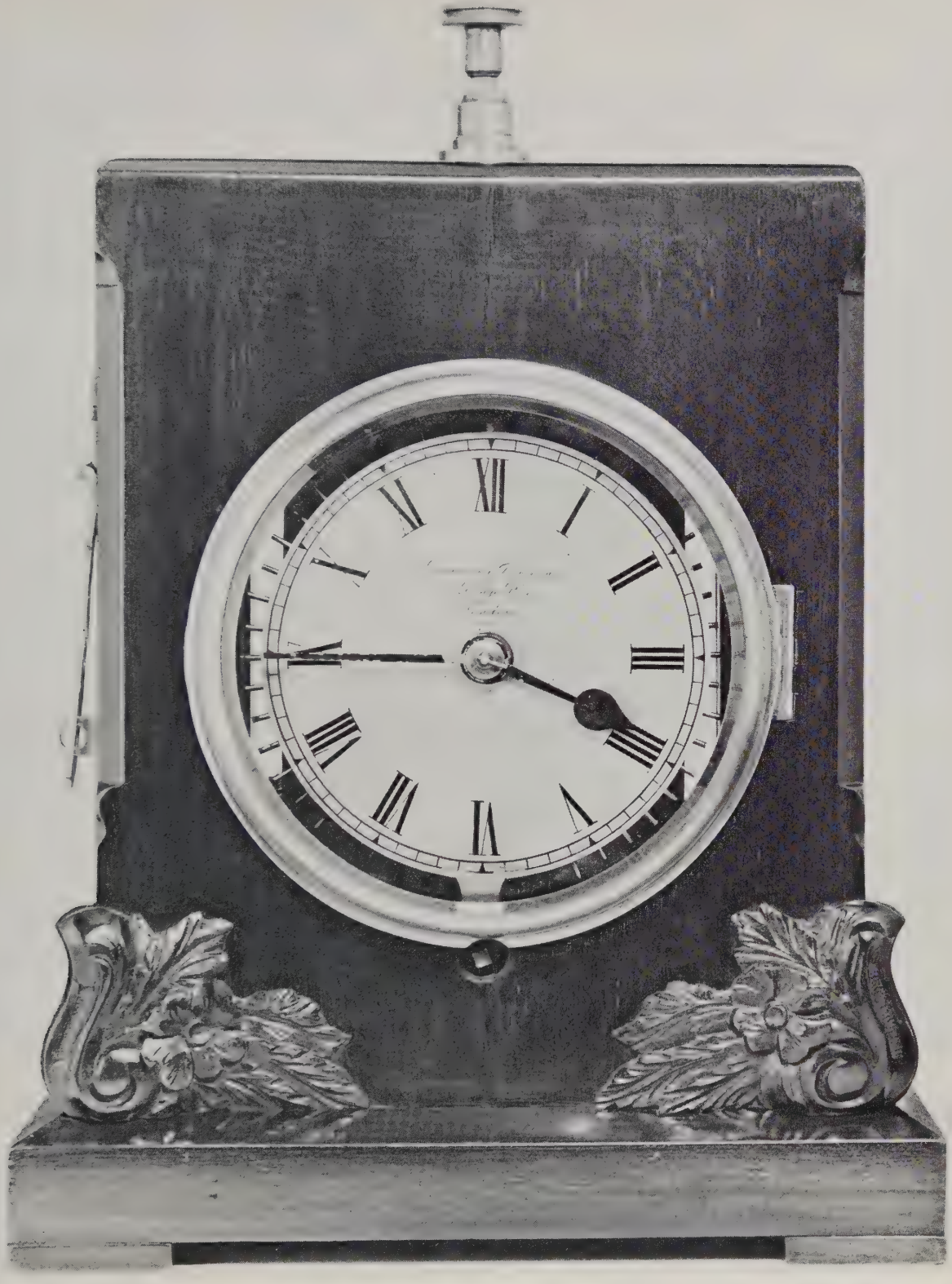


PLATE 8.

Parkinson & Frodsham. 5 Budge Row. Night-watchman's clock.

By the courtesy of Bobinet Limited. Photograph by M. Maggs.

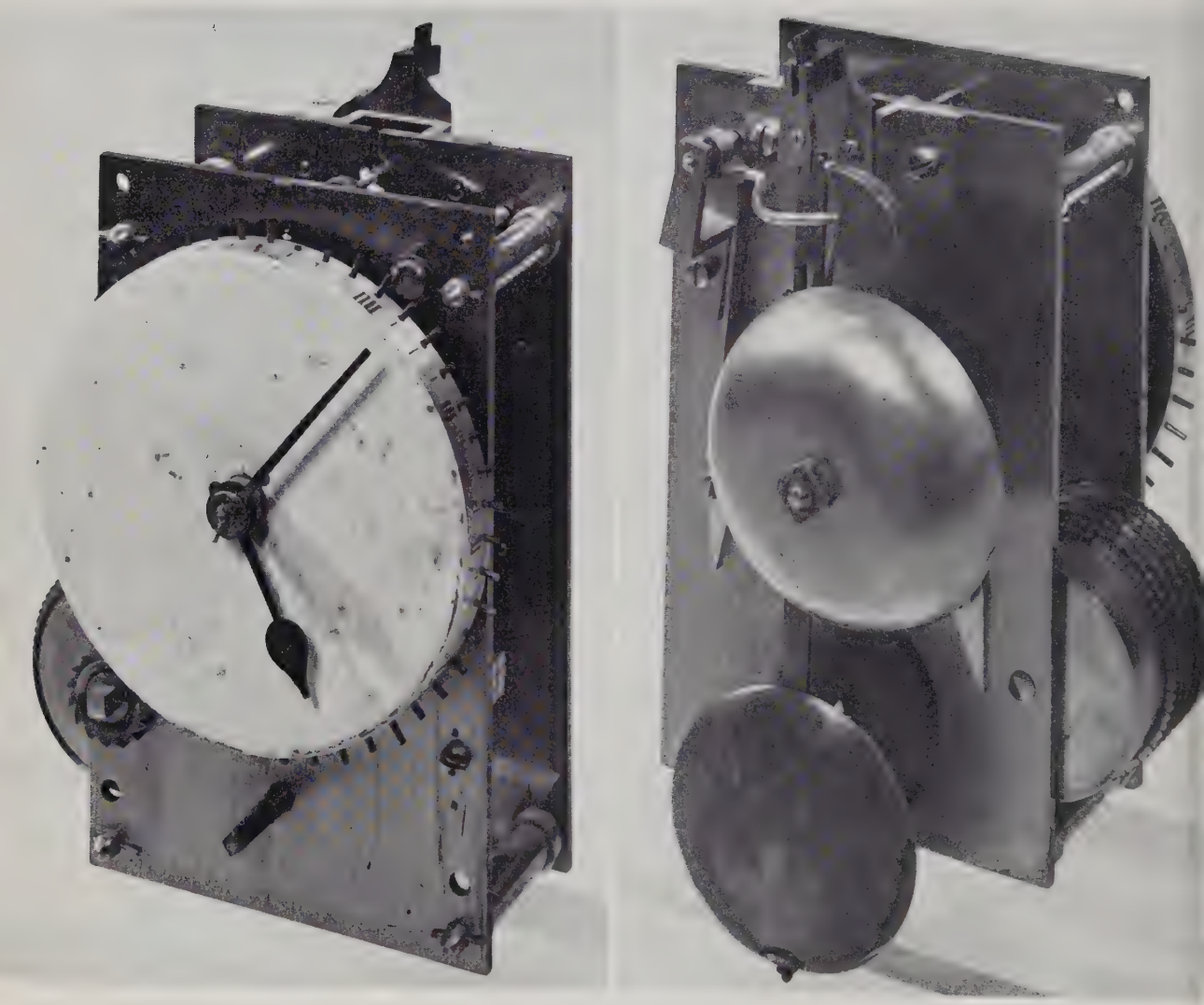


PLATE 9.

Parkinson & Frodsham. 5 Budge Row. Night-watchman's clock.
Left : Under the dial. Right : Rear view. Note the bell.

By the courtesy of Bobinet Limited. Photographs by M. Maggs.

PLATE 10.
Parkinson & Frodsham
No. 307. Pocket chronometer.
Note the regulator.

PLATE 11.
Parkinson & Frodsham
No. 478. Pocket chronometer.
H.M. 1802. Silver pair cases.
By the courtesy of A. G. Randall.

PLATE 12.
Parkinson & Frodsham No. 510.
The remains of the pocket chronometer which used to belong to Lieut. Wynne.

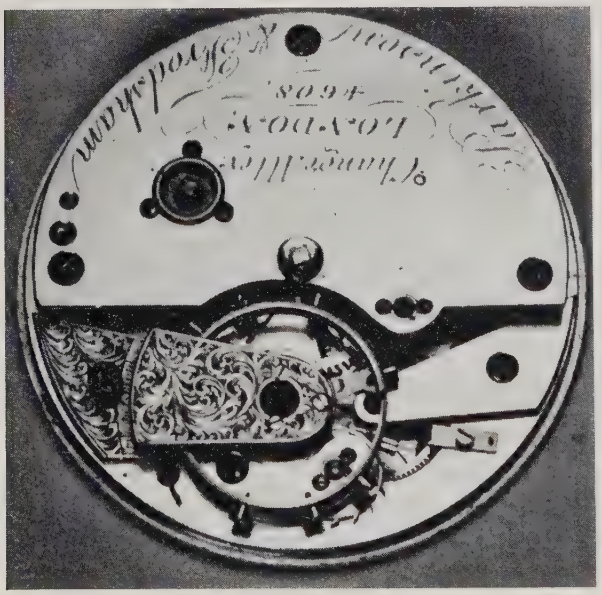


PLATE 13.
Parkinson & Frodsham No. 4608.
$\frac{1}{2}$ plate pocket chronometer.
By the courtesy of British Museum.

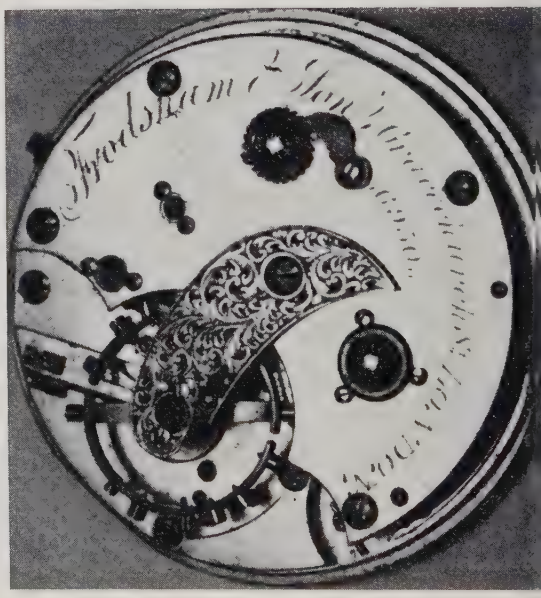


PLATE 14.
Frodsham & Son, Gracechurch Street,
No. 6950.
$\frac{3}{4}$ plate pocket chronometer. Simple detent p
a return spring detent.
By the courtesy of British Muse

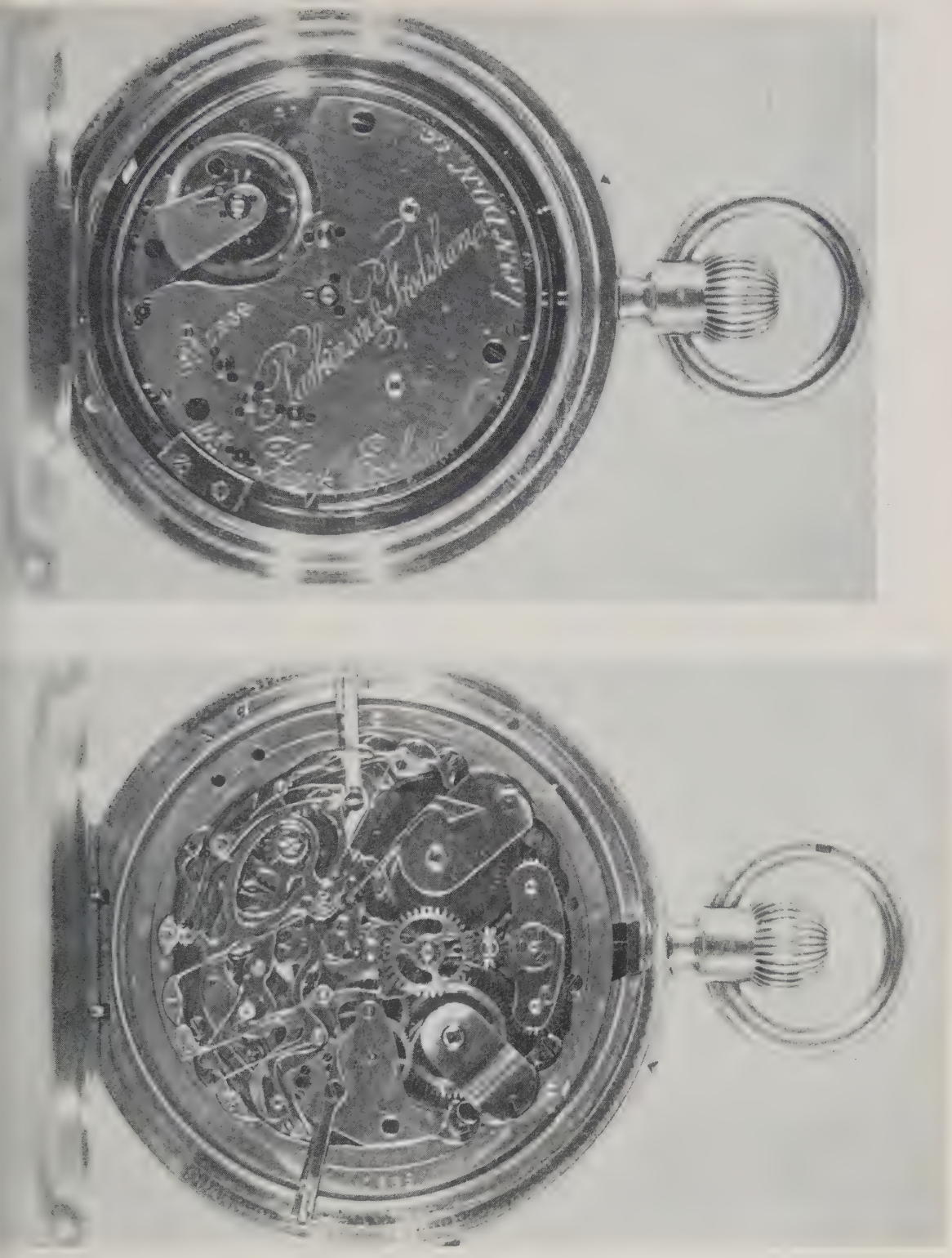


PLATE 15.

Parkinson & Frodsham, 15B Royal Exchange, London. No. 7269. H.M. 1904.
Minute repeating clock watch. Free sprung with lever escapement.

PLATE 16.

Henry Frodsham.

PLATE 17.
Frances Louisa Frodsham, wife of Henry.

PLATE 18.

Henry Frodsham, élève of Parkinson & Frodsham, Change Alley, London. This is a large deck watch, the dial being 60 mm. in diameter. No. 46267.

PLATE 19.

Henry Frodsham, London, No. 46267. Deck watch.
The movement is mounted in a brass bowl, rather like a small marine chronometer. Lever escapement, not free sprung.

PLATE 20.

Henry Herbert Frodsham.

PLATE 21.

Parkinson & Frodsham, 5 Budge Road.
The devastation caused by the bombing in 1944.

CHRONOMETERS.

The Honorable Board of Admiralty has been pleased to grant the Premium Prize of 170*l.* to CHARLES FRODSHAM, of No. 7, Pavement, Finsbury Square, London, for the very superior performance of his Chronometer, at the Royal Observatory, Greenwich, its mean variation being only 86 hundred parts of a second, for twelve months from actual daily observation.

Average Daily rate for each Month of Chronometers Nos 1 *and* 2 *for twelve Months, at the Royal Observatory, Greenwich; on the last Public Trial.*

No. 1.	Date.	Daily Rate	No. 2.	Daily Rate.	THERMOMETER. Max.	Min.
1830	October . .	+2 73		+6^{m} 75	69°	52°
	November .	3 45		6 98	59	45
	December	3 29		6 97	50	27
1831	January .	3 44		6 59	50	35
	February .	3 43		6 85	59	34
	March . .	3 66	Same date as No. 1.	7 24	58	44
	April . .	3 72		7 45	62	37
	May . .	3 76		7 24	71	52
	June . .	3 54		7 22	72	61
	July . .	3 15		7 29	78	65
	Aug. . .	3 25		7 09	77	68
	September	3 66		7 28	72	60
	October . .	3 47		7 05		

CHARLES FRODSHAM begs to observe that he has devoted much time and attention to the perfection of the Marine Chronometer, and being more desirous of procuring a well earned and lasting celebrity, than the mere present requisition of a few pounds, he has reduced his *56-HOUR INDEX CHRONOMETERS* to as low a price as will ensure the requisite excellence of the workmanship. The chronometrical parts of each instrument put forth by C. F. are effected by himself on the same principles as his prize chronometer, and contain all his recent improvements, which a series of valuable experiments just terminated, have suggested to him.

CHARLES FRODSHAM, 3, PAVEMENT.

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PLATE 22.

The Nautical Magazine, April, 1840.

CHRONOMETERS

The Honorable Board of Admiralty has been pleased to grant the Premium Prize of £170 to CHARLES FRODSHAM, of No. 7, Pavement, Finsbury Square, London, for the very superior performance of his Chronometer, at the Royal Observatory, Greenwich, its mean variation being only 86 hundred parts of a second, for twelve months from actual daily observation.

Average Daily rate for each Month of Chronometers Nos. 1 and 2 for twelve Months, at the Royal Observatory, Greenwich; on the last Public Trial.

No. 1.	Date	Daily Rate	No. 2	Daily Rate	Thermometer Max.	Thermometer Min.
1830	October	+2 73		+6″ 75	69°	52°
	November	3 45		6 98	59	45
	December	3 29		6 97	50	27
1831	January	3 44	Same date as No. 1	6 59	50	35
	February	3 43		6 85	59	34
	March	3 66		7 24	58	44
	April	3 72		7 45	62	37
	May	3 76		7 24	71	52
	June	3 54		7 22	72	61
	July	3 15		7 29	78	65
	August	3 25		7 09	77	68
	September	3 66		7 28	72	60
	October	3 47		7 05		

CHARLES FRODSHAM begs to observe that he has devoted much time and attention to the perfection of the Marine Chronometer, and being more desirous of procuring a well earned and lasting celebrity, than the mere present acquisition of a few pounds, he has reduced his *56-HOUR INDEX CHRONOMETERS* to as low a price as will ensure the requisite excellence of the workmanship. The chronometrical parts of each instrument put forth by C.F. are effected by himself on the same principles as his prize chronometer, and contain all his recent improvements, which a series of valuable experiments just terminated, have suggested to him.

CHARLES FRODSHAM, 7, PAVEMENT

PLATE 22a.

Clarification of the advertisement on the inner side of the front blue paper cover of the *Nautical Magazine,* No. 4, dated April, 1840. As shown in Plate 22.

PLATE 23.

Charles Frodsham marine chronometer No. 1614.

7 Pavement, Finsbury Square, London. The seconds dial is at VI.

PLATE 24.

Marine chronometer No. 1724. Charles Frodsham. 7 Pavement, Finsbury Square. Note that the seconds dial is at XII.

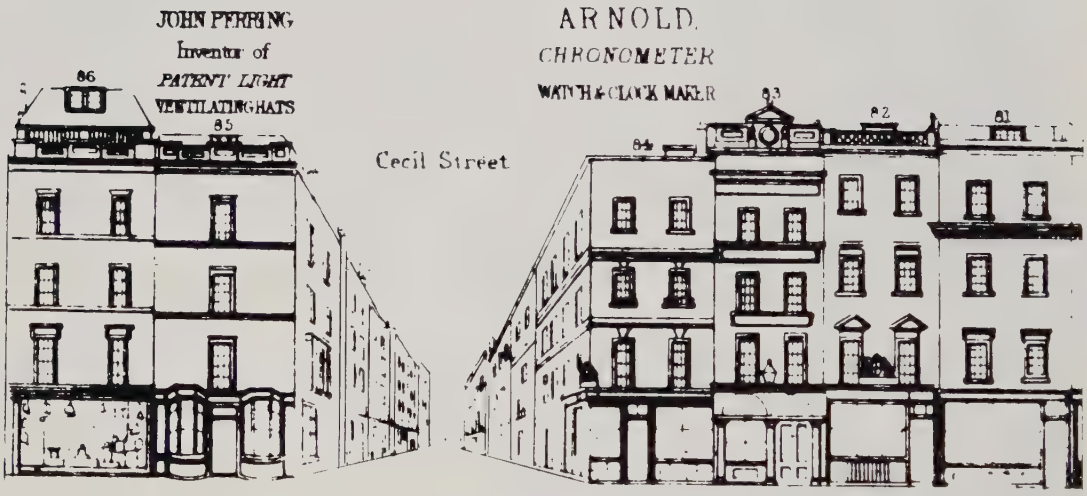


PLATE 25.

84 The Strand c. 1838 (From Tallis's London Streetviews).

PLATE 25a

84 The Strand c. 1880 as altered by Charles Frodsham to have an extra floor and an attic.

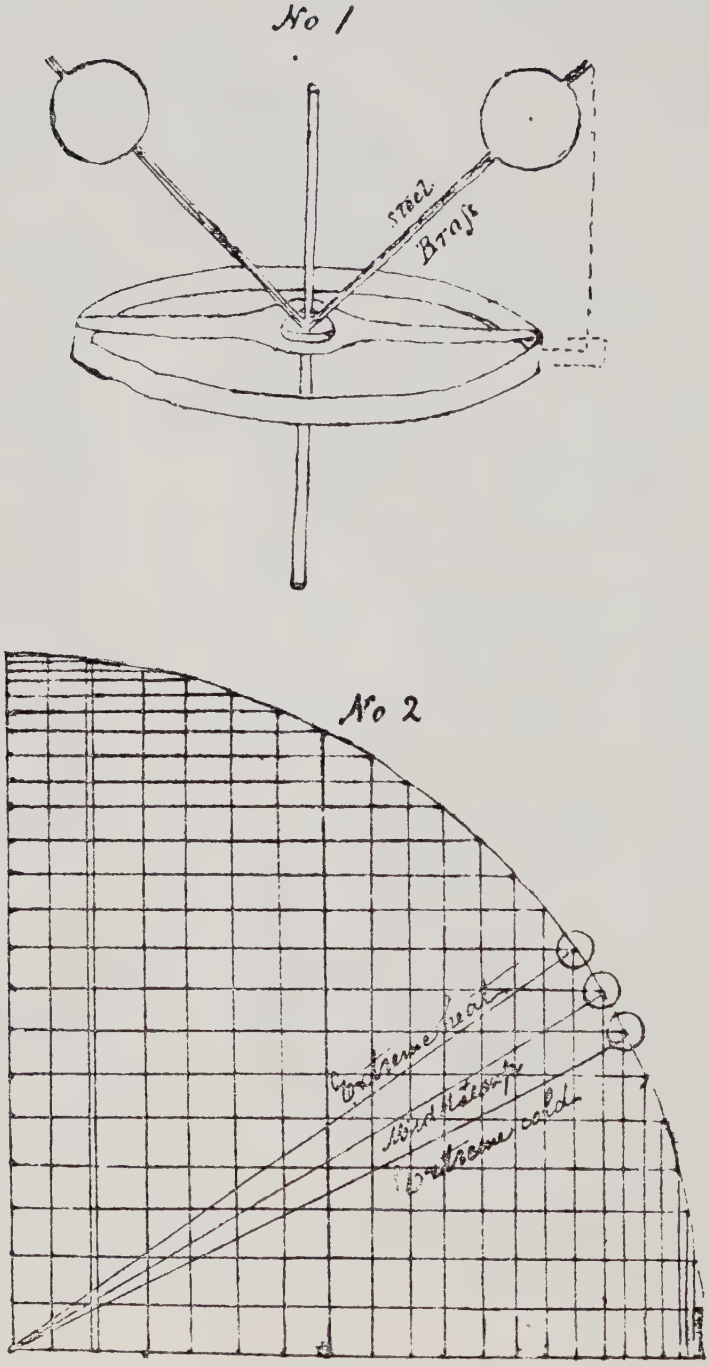
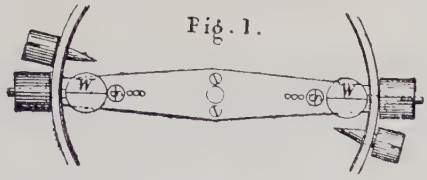
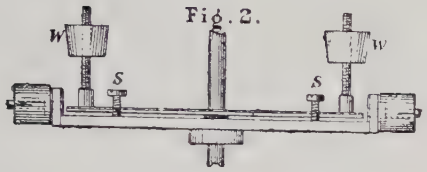
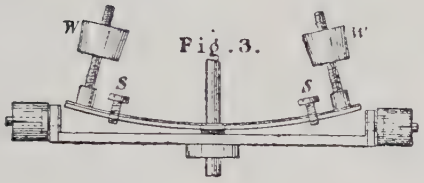


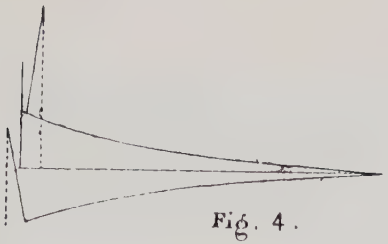
PLATE 26.

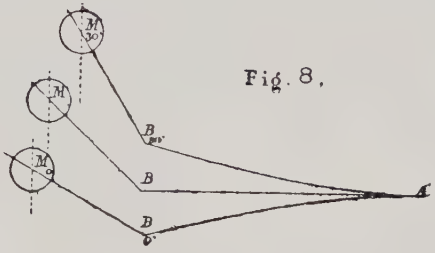
Charles Frodsham's letter to Airy. November 14th, 1843

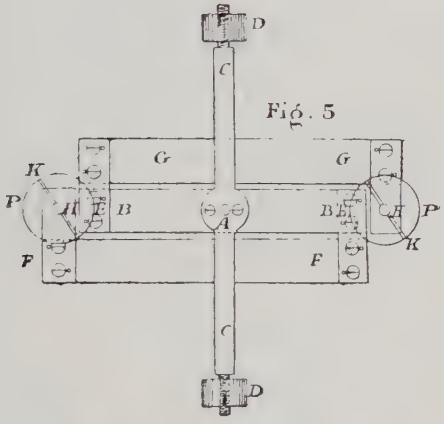


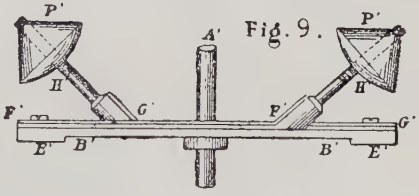


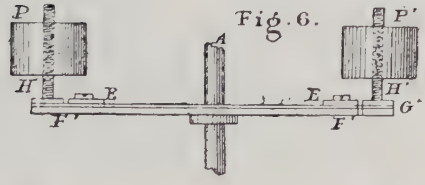


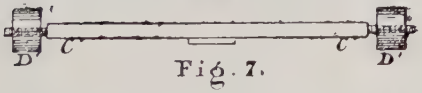












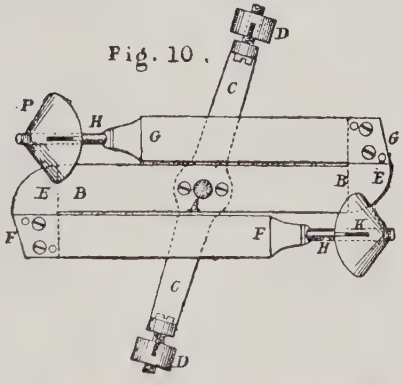


PLATE 27.

The Frodsham-Arnold balance, Figs. 1 - 4

The Frodsham Hartnup balance, Figs. 5 - 7

The Winnerl balance, Figs. 8 - 11

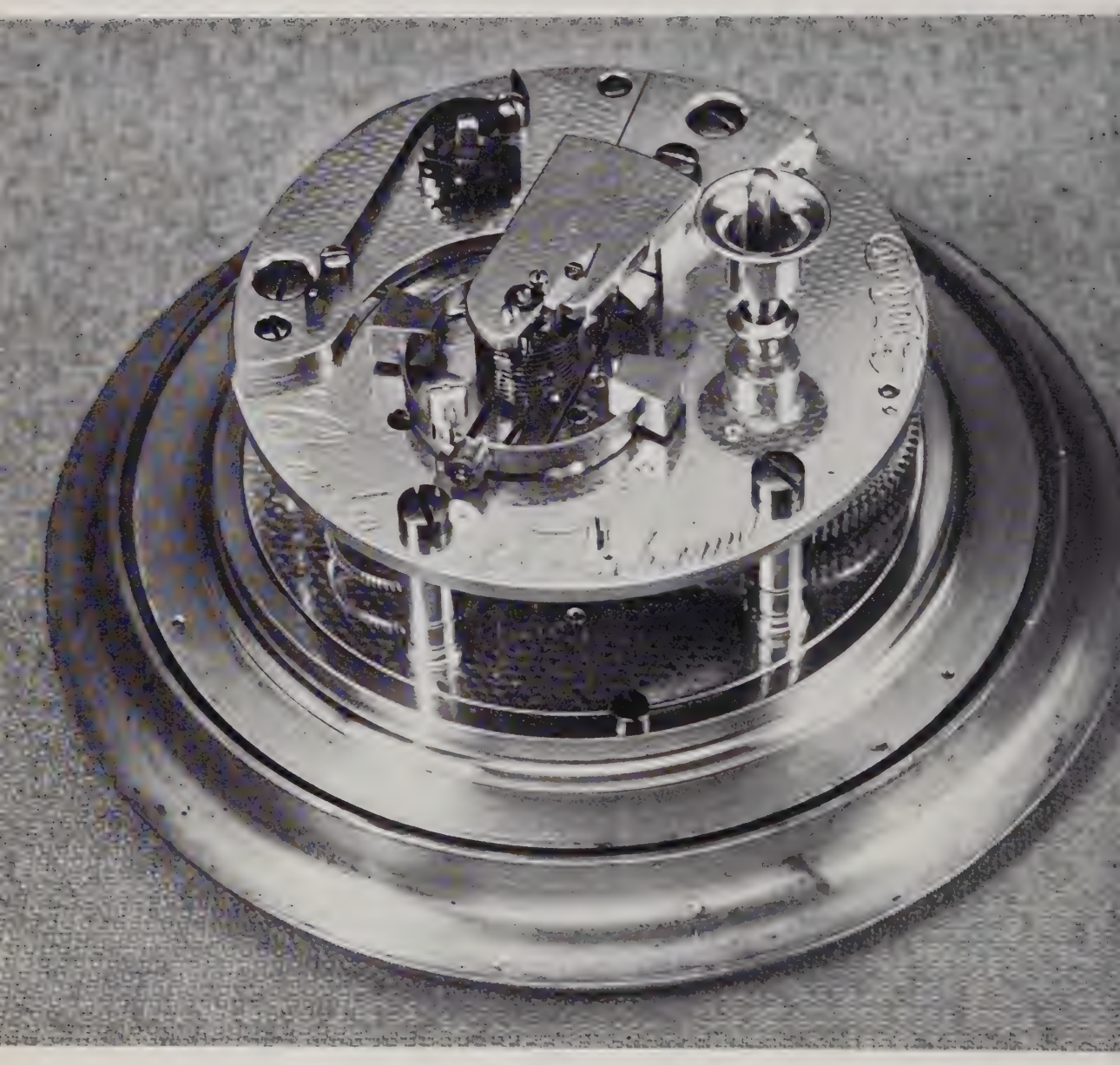


PLATE 28

Charles Frodsham, 84 The Strand, London No. 3311. Frodsham-Hartnup Balance.

It has the type of balance which he called 'A double compound micrometric equation balance. Similar to the one described in the 1862 South Kensington Exhibition catalogue. Note the reversed fusee.

By the courtesy of Asprey & Company Ltd.

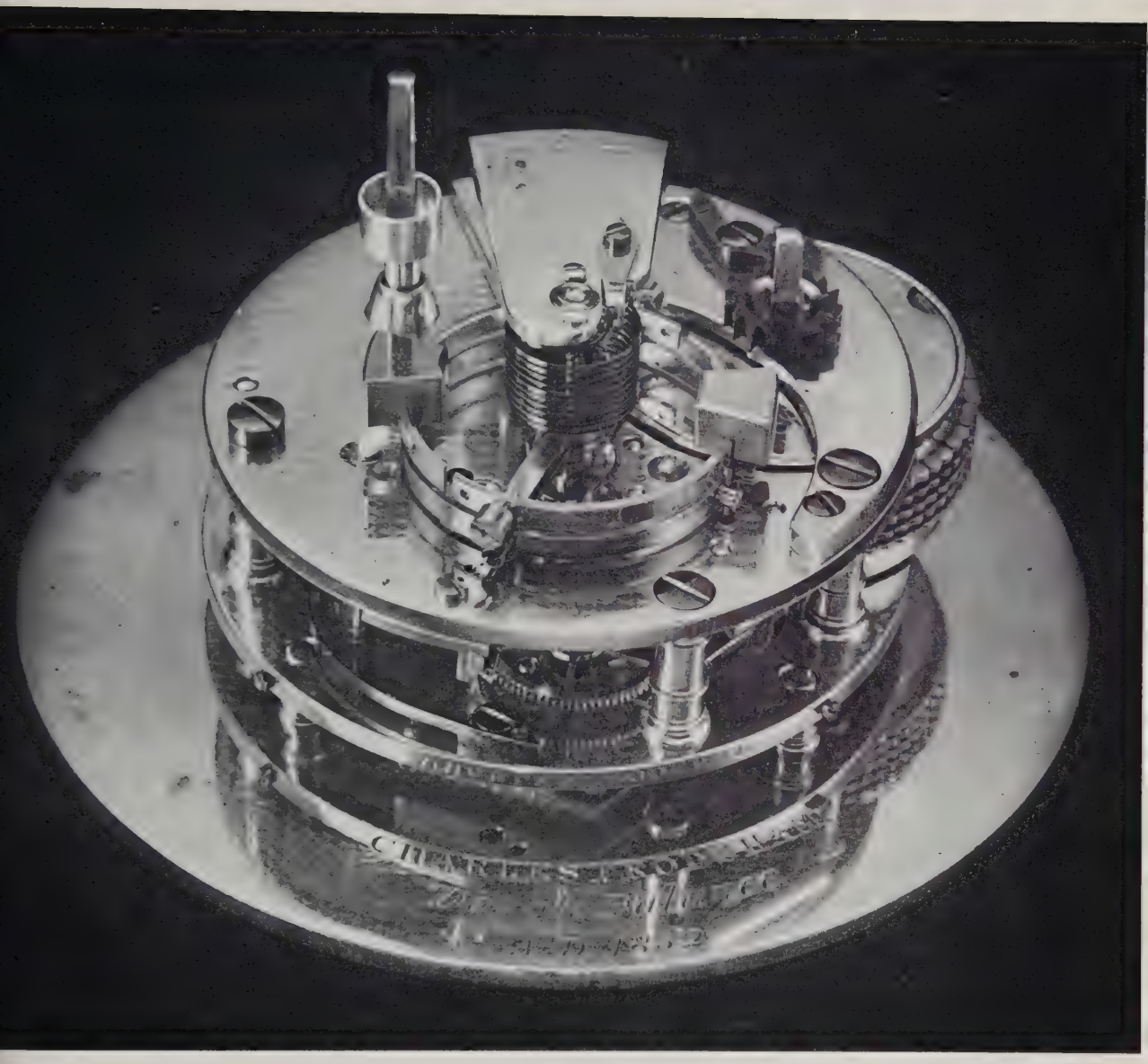
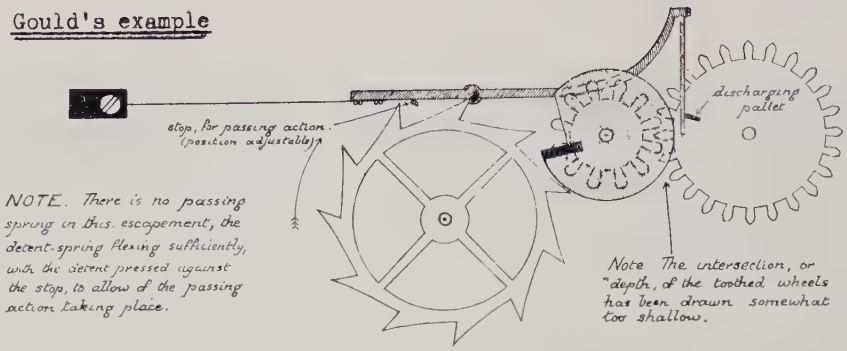
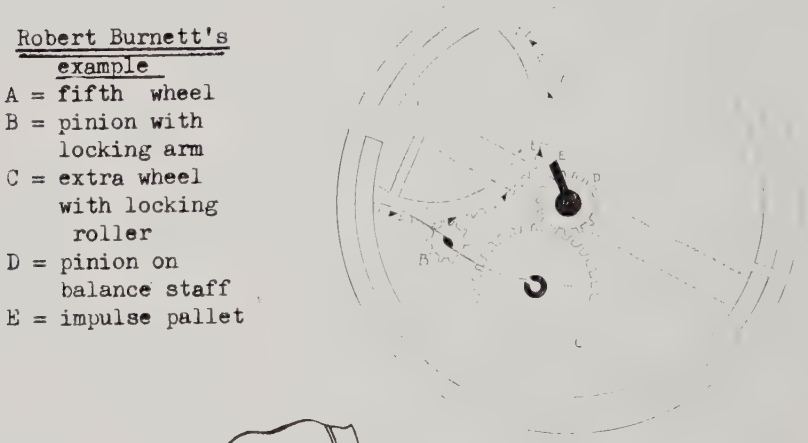


PLATE 29

Charles Frodsham marine chronometer No. 4006. Engraved 'Double balance 1852'. The fusee is not reversed. The upper balance is an ordinary Earnshaw type balance. The lower balance has its metals reversed, i.e. the steel is on the outer side; it has 6 screws and its rim is split at about half way between its arms.

By the courtesy of Asprey & Company Ltd.


Gould's example
stop, for passing action (position adjustable)
discharging pallet
NOTE. There is no passing spring in this escapement, the detent-spring flexing sufficiently, with the detent pressed against the stop, to allow of the passing action taking place.
Note The intersection, or "depth, of the toothed wheels has been drawn somewhat too shallow.


Robert Burnett's example
A = fifth wheel
B = pinion with locking arm
C = extra wheel with locking roller
D = pinion on balance staff
E = impulse pallet

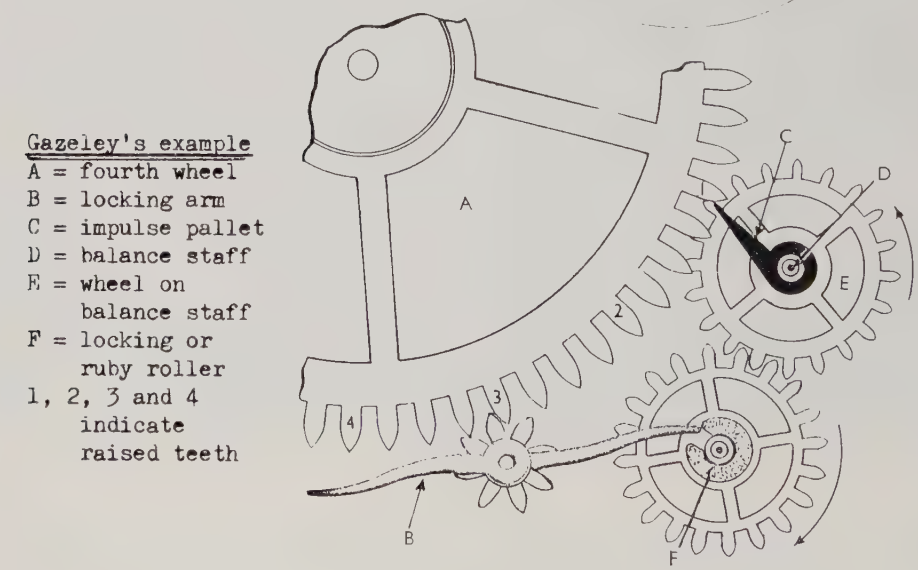
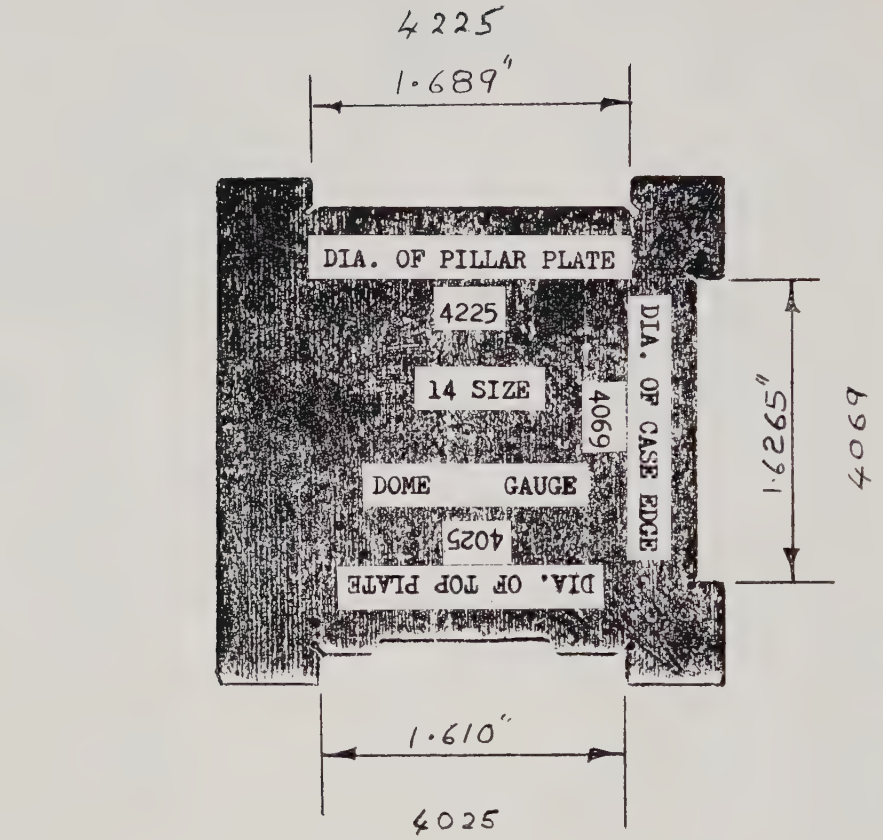
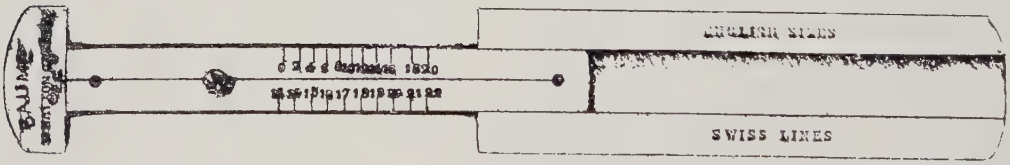


PLATE 30.

James Ferguson Cole's Double Rotary Escapement

PLATE 31.
Charles Frodsham.





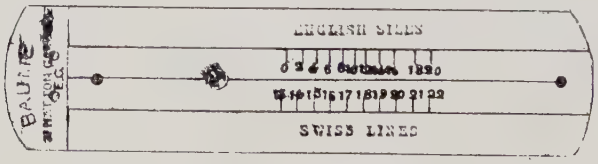


PLATE 32

Watch Movement Gauges. Above : A gauge using the J. Wycherley scale. Below : Baume, 21 Hatton Garden, E.C. A Lancashire movement gauge plus a line gauge.

Not to scale.

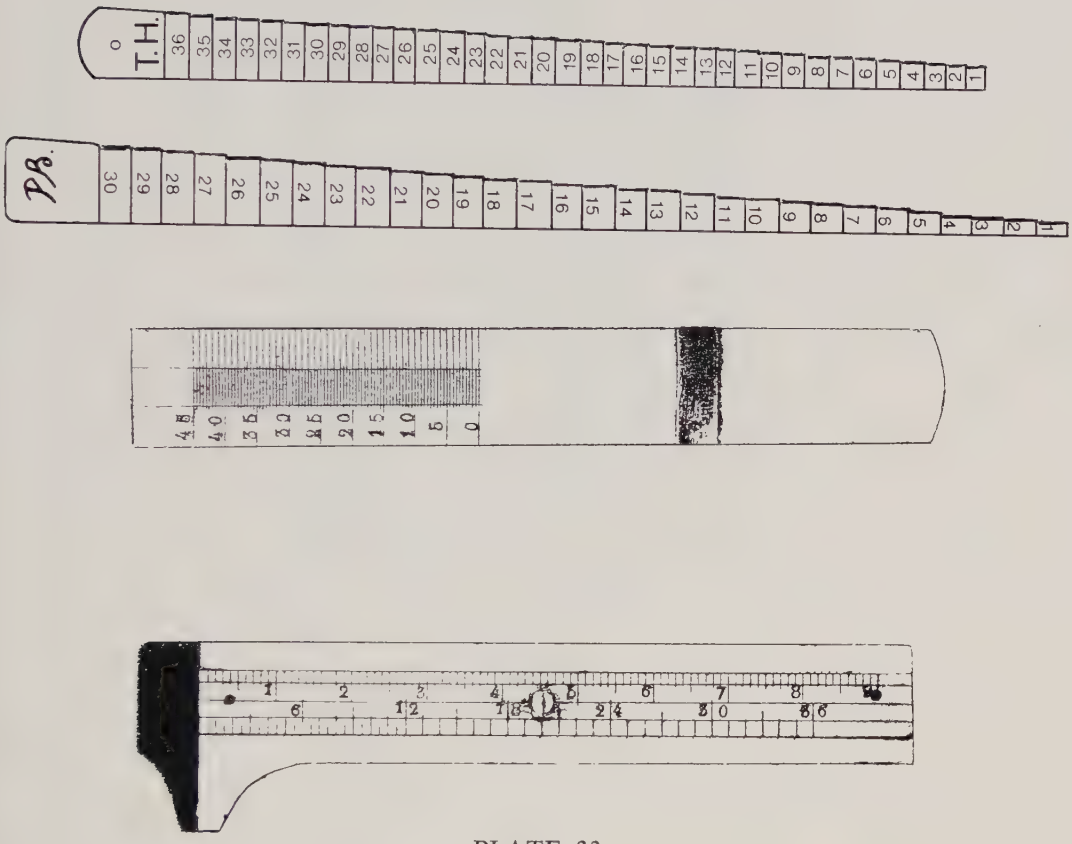


PLATE 33

Above : **Two Pillar Gauges.** Top : A Lancashire Pillar Gauge. T.H.

Below it : A Line Pillar Gauge. P.B.

Below : **Two Watch Glass Gauges.**

Top of these two : A Lancashire or English Watch Glass Gauge.

Lowermost : A Gauge reading Millimetres and Lines.

All actual size.

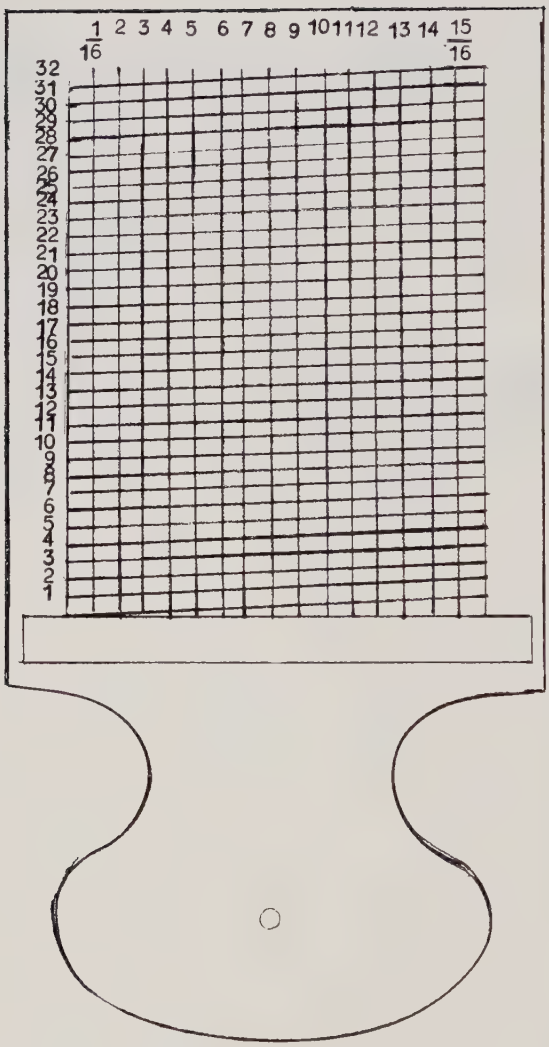


PLATE 34.

A Line Gauge. Drawn approximately to scale.

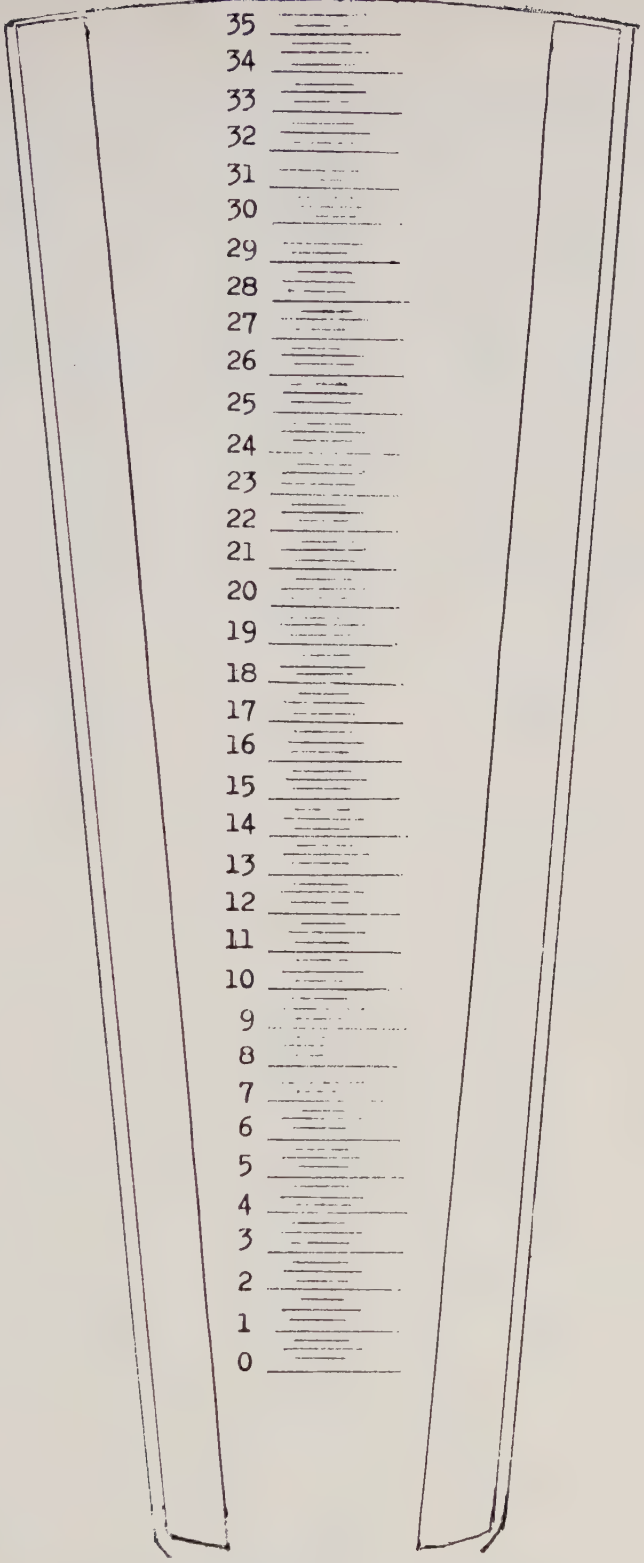


PLATE 35.

Lancashire Watch Glass Gauge.

Actual size.

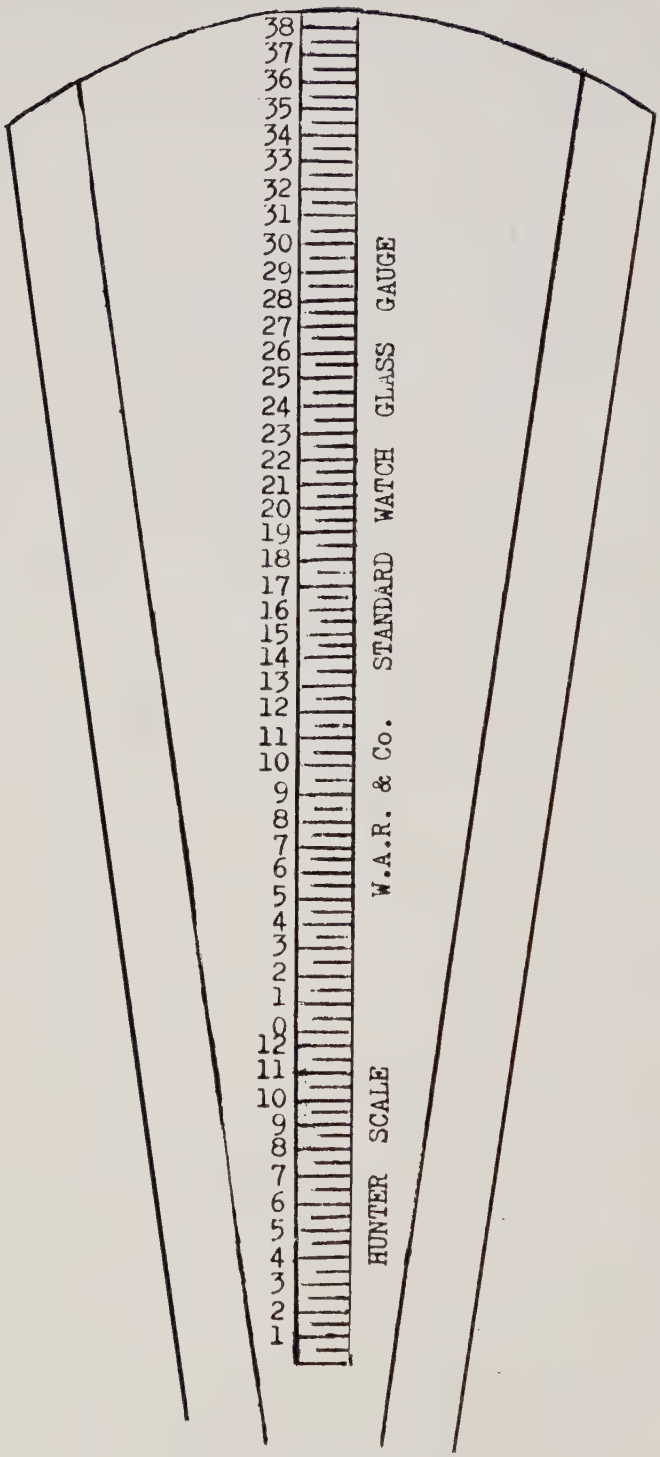


PLATE 36.

Lancashire Watch Glass Gauge.
Actual size.

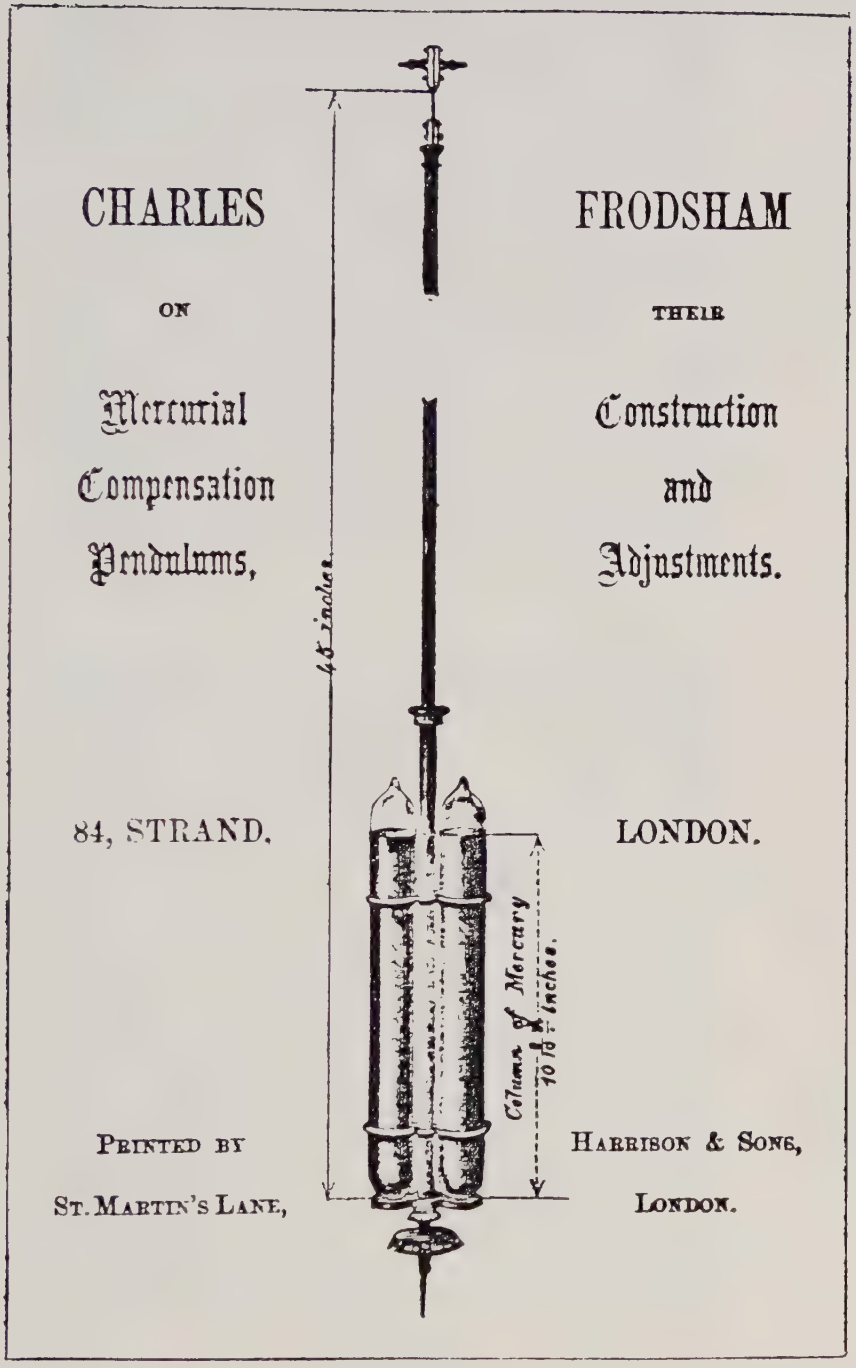
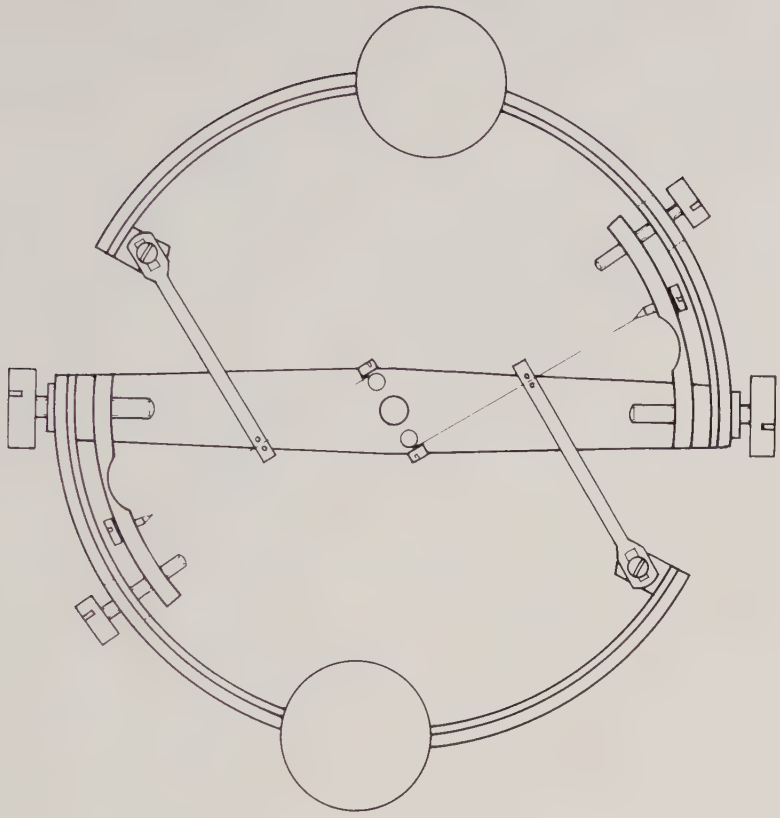


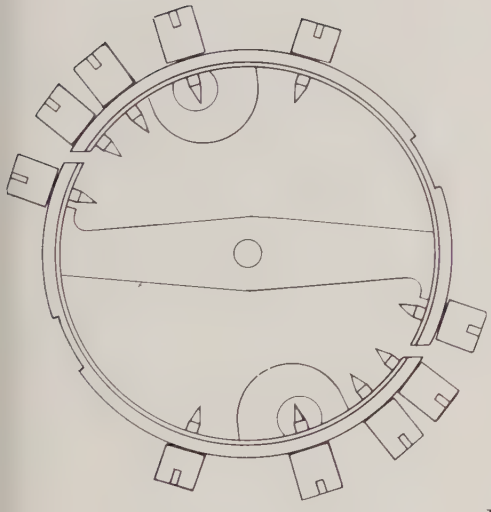
PLATE 37.

Charles Frodsham's Mercurial Pendulum.

PLATE 38.

C. Mill Frodsham, Junr, élève de Charles Frodsham, 84 Strand, London. No. 3/3308. Note the broad arrow Observatory mark on the dial and the special balance.





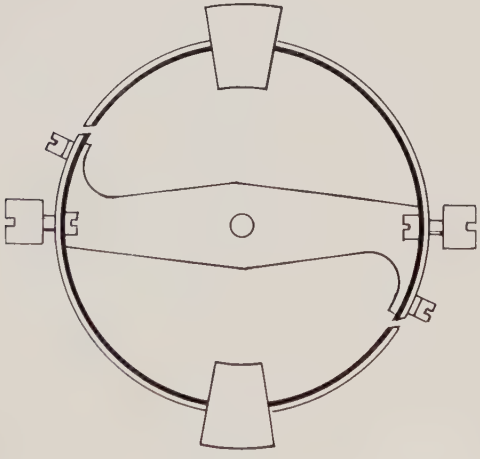


PLATE 39.

Balances :

Above: Charles Mill Frodsham, Marine Chronometer, No. 3/3308.
Below, left : Parkinson & Frodsham, Duplex Escapement, No. 2441.
Note the thinned section of brass and the ? reinforcing steel semi-circles.
Below, right : Parkinson & Frodsham, Pocket Chronometer, No. 4530.

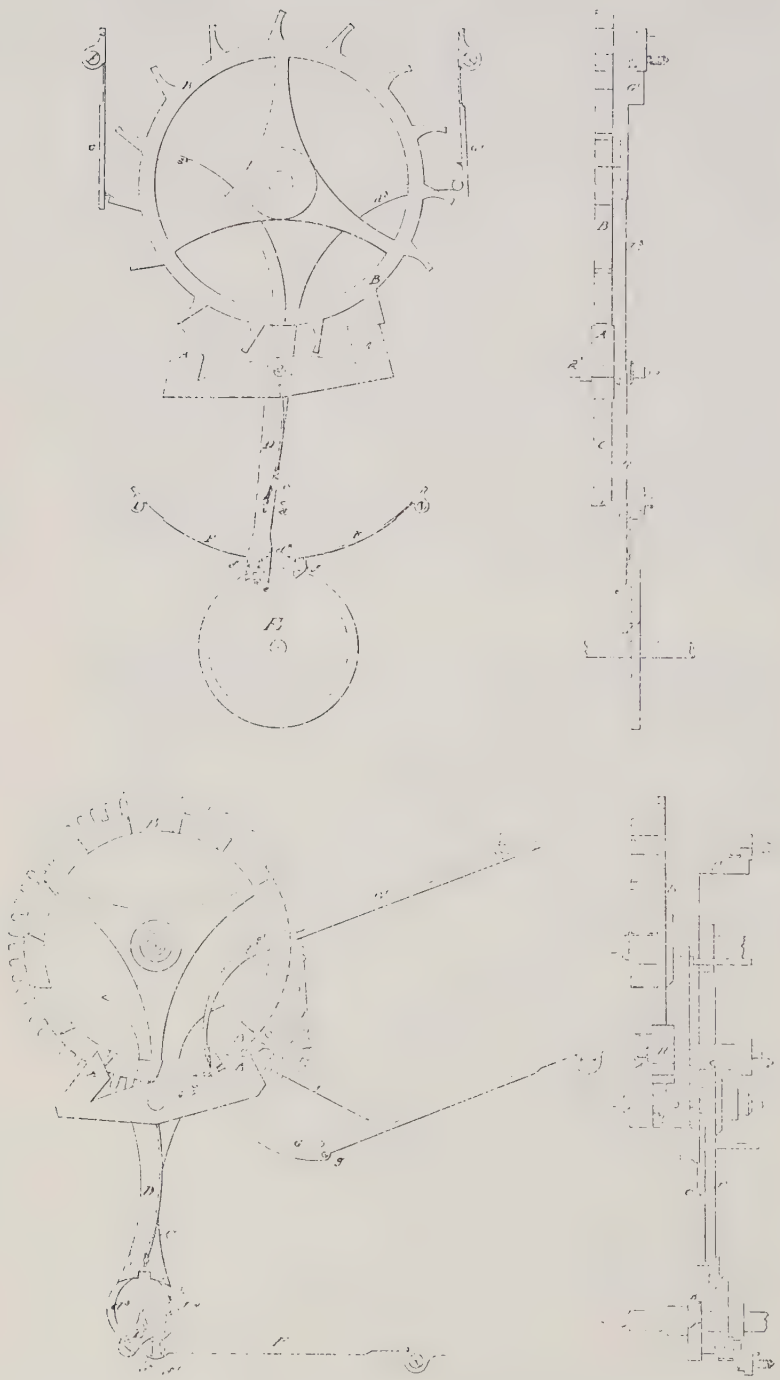


PLATE 40.

Harrison Mill Frodsham's Patent No. 191. A.D. 1877.

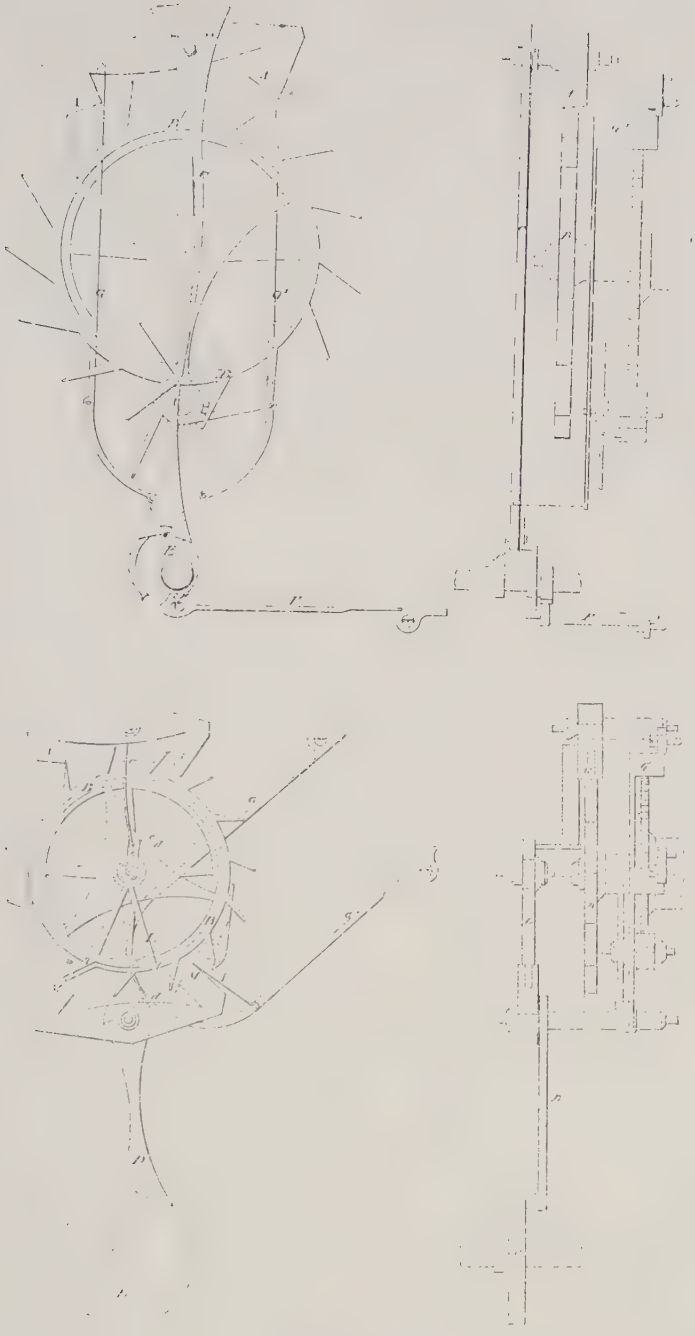


PLATE 41.

Harrison Mill Frodsham's Patent No. 191. A.D. 1877.

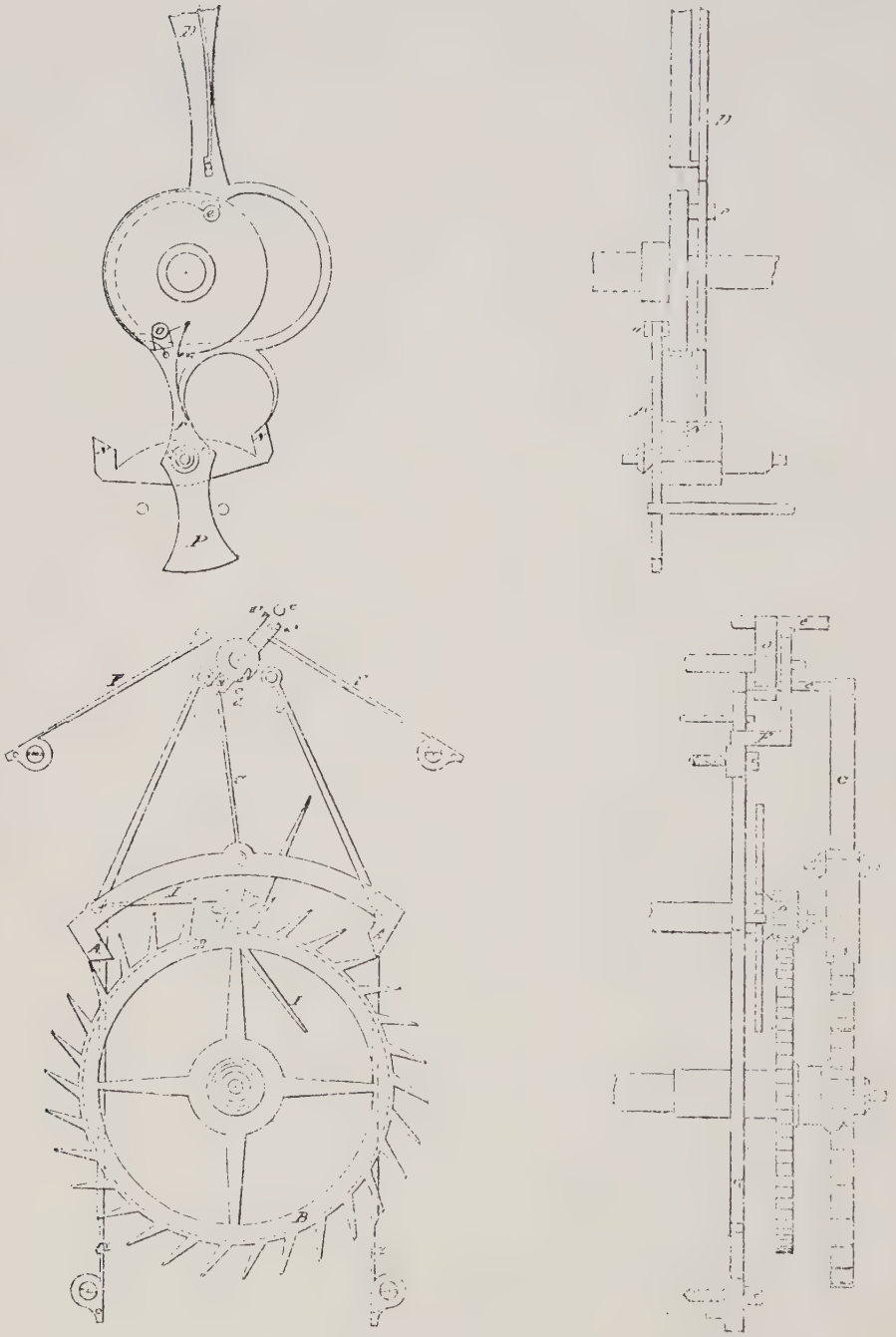


PLATE 42.

Harrison Mill Frodsham's Patent No. 191. A.D. 1877.

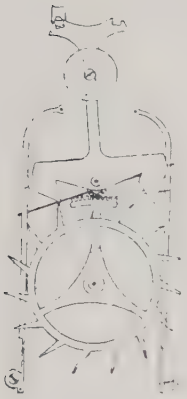


Fig. 2.

Fig. 3.

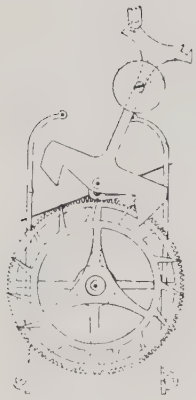


Fig. 1.

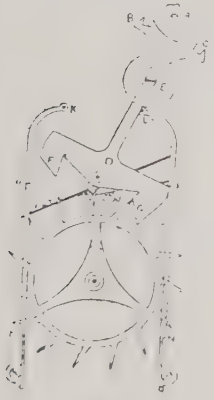


Fig. 5.

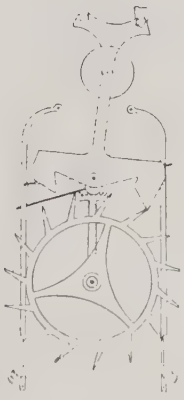


Fig. 6.

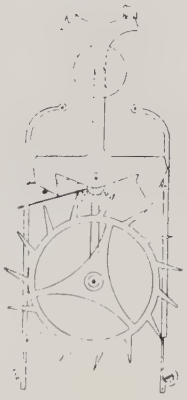


Fig. 7.

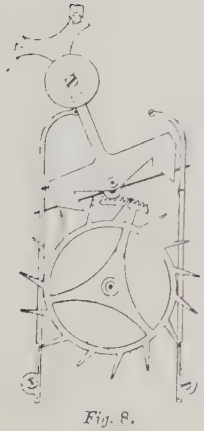


Fig. 8.

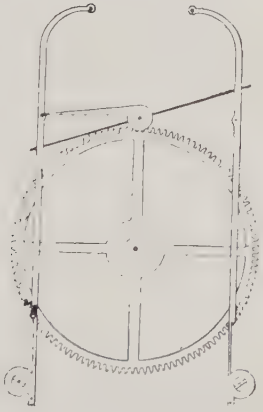


Fig. 9.

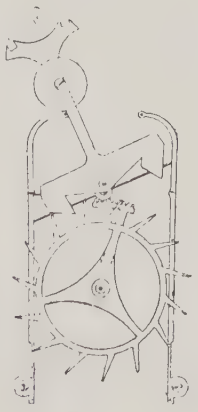


Fig. 10.

PLATE 43.

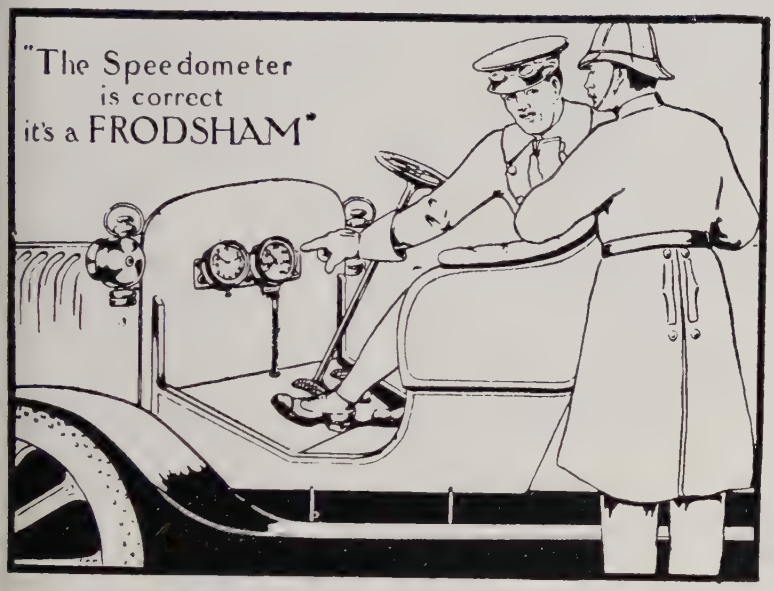
H.M. Frodsham's Remontoire. The improved version as applied to a pendulum by contact with the lower end of the pendulum. 1886.

PLATE 44.
115 New Bond Street. 1896 - 1914.

CHAS. FRODSHAM & Co., Ltd.

WATCHMAKERS (by Appointment to H.M. the King).

115 NEW BOND ST., LONDON



AND

(Speedometers)

17 Dering St.,
London, W.

Fine Watches,
Clocks, and ::

ENGLISH

Speedometers,

from **£4 4/-**

Reproduced from a Scottish newspaper, 1911

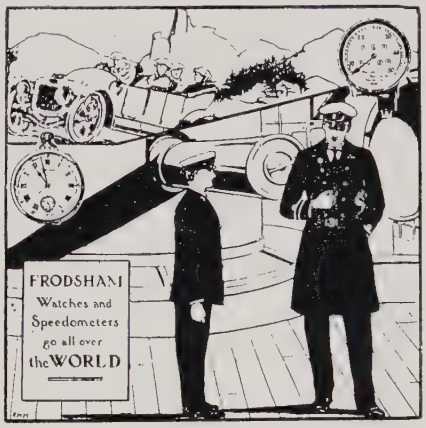
PLATE 45.

Advertisements from the past. The Frodsham Speedometer.

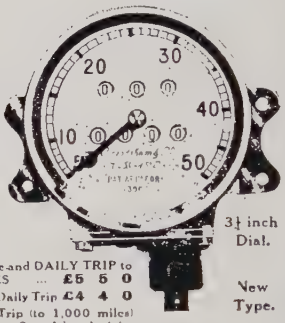
Watchmakers by Appointment

Chas. FRODSHAM & CO. Ltd.

17. DERING ST., LONDON. W.



BEST ENGLISH
SPEEDOMETERS.



Illustrated Catalogue free by post.

3½ inch Dial.

New Type.

Total Mileage and DAILY TRIP to 1,000 MILES ... £5 5 0
WITHOUT Daily Trip £4 4 0
With Daily Trip (to 1,000 miles) and Maximum Speed hand, 4 in. dial £8 8 0

*Watch & Clock Dep*t 115, New Bond St., — *Speedometers*, 17, Dering St., W.

Chas. Frodsham & Company, Ltd

Reproduced from the "Motor" August, 1911

Frodsham's Chronometers and Watches are known all over the world.

Chas. Frodsham

& Co, Ltd.

By Appointment to H.M. THE KING.

Holders of the Kew Obs. Record for English Watches, 93.9.

CHRONOMETERS, REPEATERS, AND FINE ENGLISH WATCHES.

CARRIAGE AND OTHER CLOCKS.

SUPERIOR SPEEDOMETERS FOR MOTOR-CARS WITH DAILY TRIP - £5 5 0.

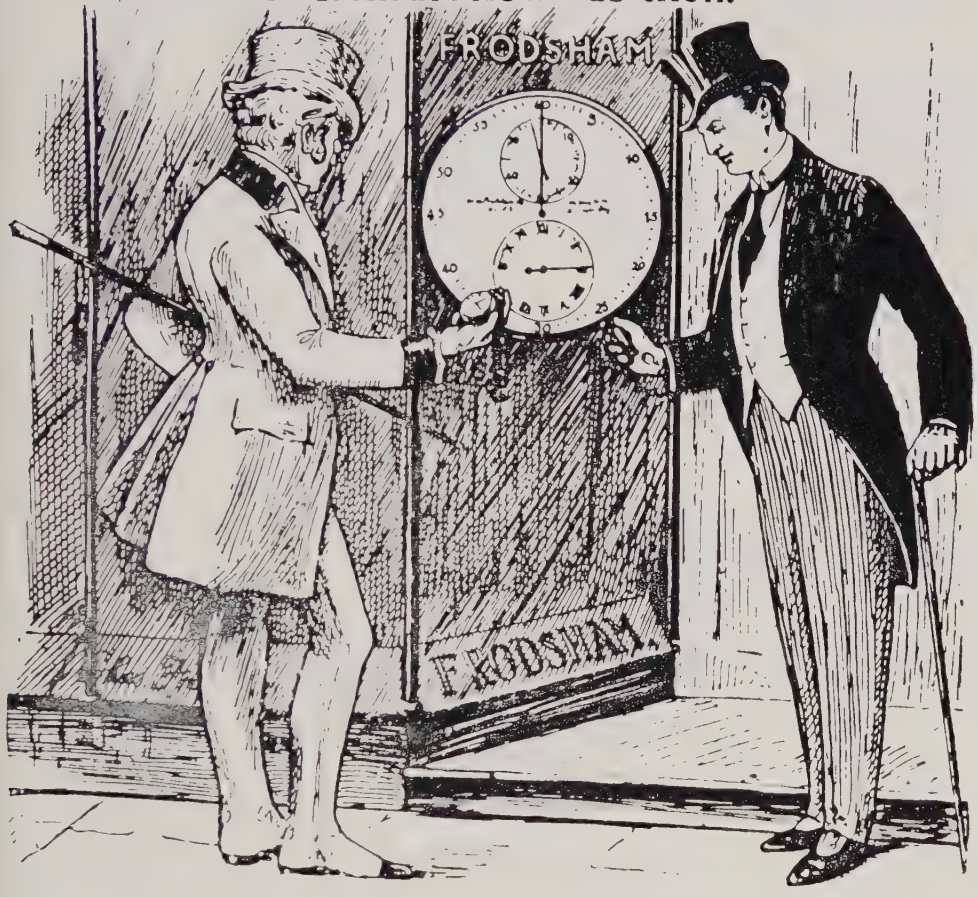
115 NEW BOND STREET,
AND 17 DERING STREET,
LONDON, W.

Reproduced from the "Farm St. Calendar" 1911

PLATE 46.

Advertisements from the past. Speedometers and Watches.

1850 Both FRODSHAMS - Both Correct. As Reliable now - as then. 1911



FINE ENGLISH WATCHES.

New Thin Model, in 18-ct. Gold Cases, Crystal Front, Hunters or Half-Hunters, 20 Gns., 25 Gns., and up to 55 Gns. (best). Repeaters, Split-Seconds, "Tourbillon," and other exceptional watches always in stock. Best English Clocks, etc.

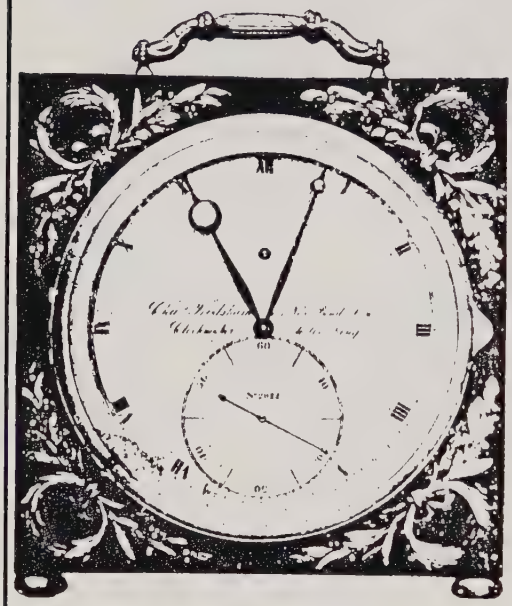
Reproduced from the "Bystander" March, 1911

PLATE 47.

Advertisements from the past. The Frodsham Watch.

FINE ENGLISH WATCHES

25 to 55 Guineas.



Repeaters

Chronographs

"TOURBILLON" Watches

always in Stock

(One with 91.6 Marks Kew Observatory).

CARRIAGE CLOCKS

With Deep-Toned Gong.

£10 10s.

Study or Library Clock

In Rosewood Case, with fine Oxidised Mounts,

£26 5 0

Reproductions of the

"Sedan Chair" Clocks

Good timekeepers and very quaint

£5 5 0

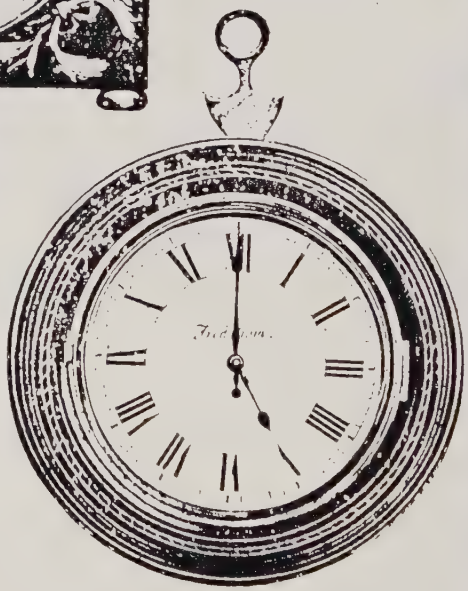
Reproductions of

Louis XV. & XVI. Clocks

FRODSHAM SPEEDOMETERS

(at 17, Dering Street, W.), from

£3 3 0 to £8 8 0



"SEDAN CHAIR" CLOCK

(as above). Can be hung on a simple nail in any room.

CHAS. FRODSHAM & CO., Ld., 115, NEW BOND ST., LONDON, W.

Reproduced from "Country Life" December, 1911

PLATE 48.

Advertisements from the past.

An '**Upside Down**' clock and a '**Sedan Chair**' clock.

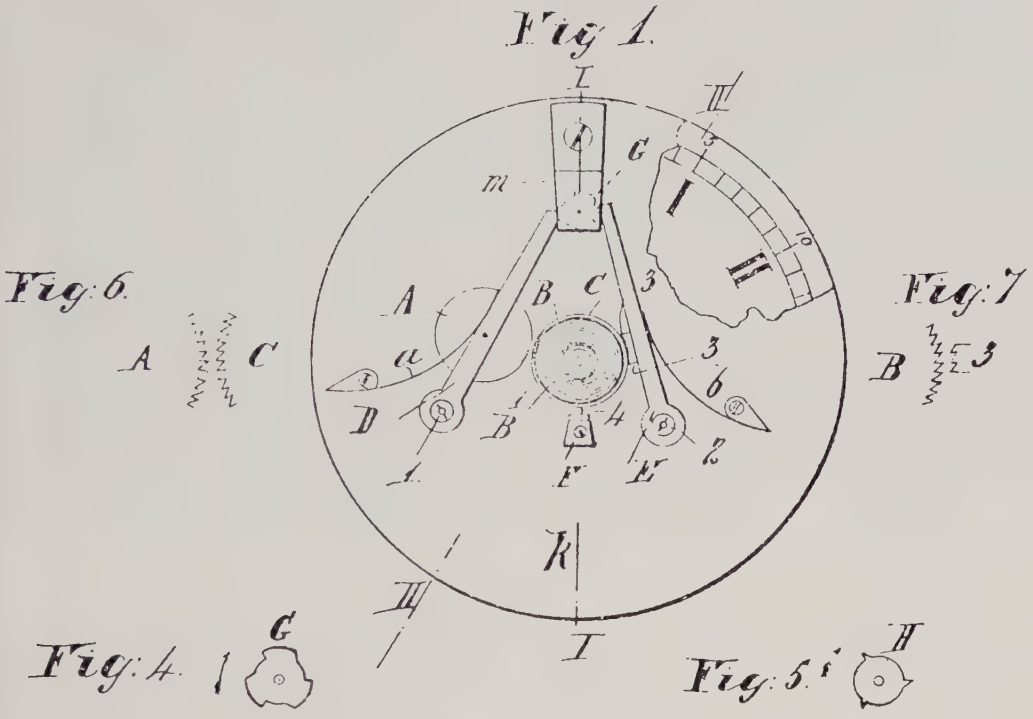


PLATE 49.

H. J. Furneaux's Patent No. 4189. A.D. 1904.

1.

2.

3.

4.

PLATE 50.

Charles Frodsham & Co. Ltd. Reproduction Clocks.

1. The Markham. 2. The Tregent. 3. The Tompion. 4. The Colley.

PLATE 50a.
Another version of " The Tompion " (without the top appliqué.)

5.

6.

7.

8.

PLATE 51.

Charles Frodsham & Co. Ltd. Reproduction Clocks.

5. The Cumming. 6. The Murray. 7. The Cole. 8. The Breguet.

9.

10.

11.

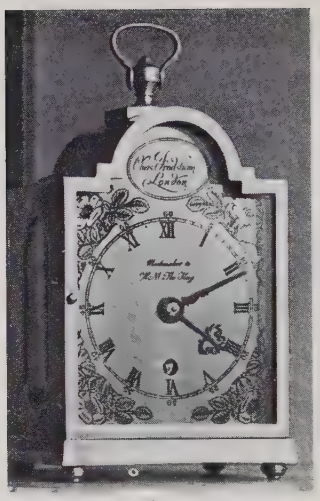
12.

PLATE 52.

Charles Frodsham & Co. Ltd. Reproduction Clocks.
9. The Ellicott. 10. The Grant. 11. The McCabe. 12. The Emery.

13.

14.



15.

18.

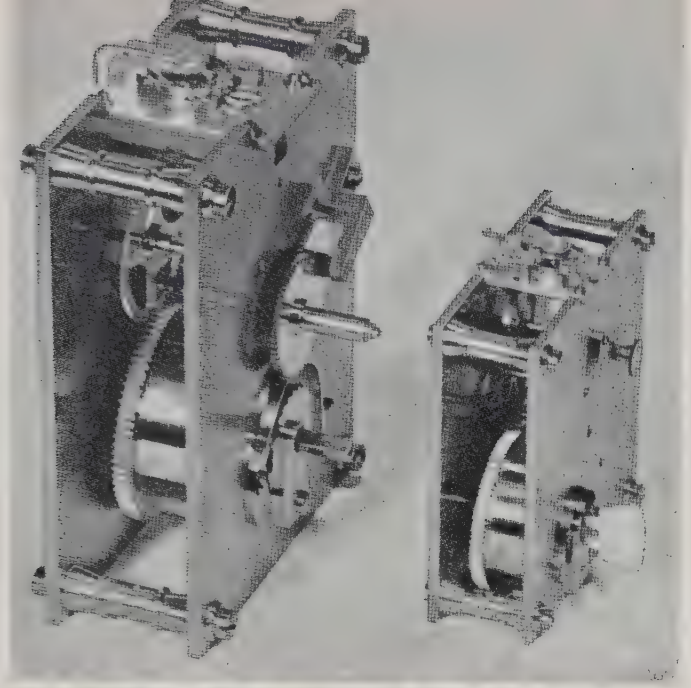
19.

16.

17.

PLATE 53.

Charles Frodsham & Co. Ltd. Reproduction Clocks.
13. The Chippendale. 14. The Princess. 15. The Viennese. 16. The Peckover. 17. The Frodsham. 18. The Quare Grandmother Clock. 19. The Gould Grandmother Clock.



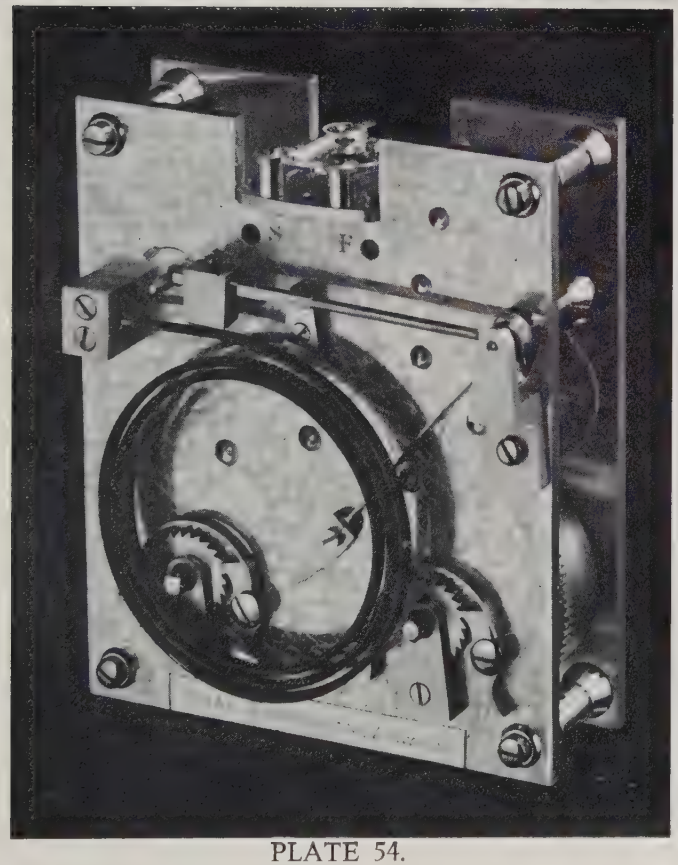
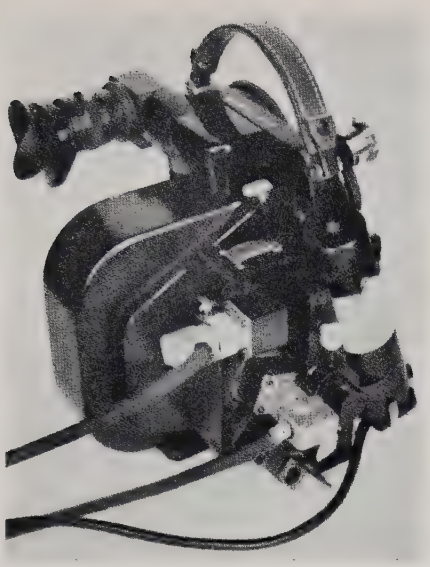


PLATE 54.

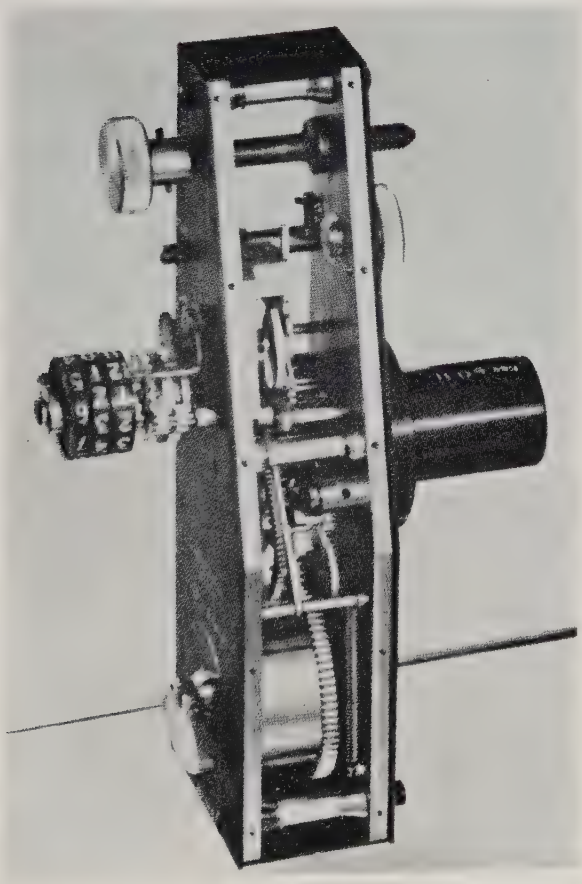
The Movements used in Reproduction Clocks.

Above : The larger movement, $4\frac{1}{2}''$ x $3\frac{1}{4}''$ x $1\frac{3}{8}''$.
The smaller movement, $2\frac{3}{4}''$ x $2\frac{1}{2}''$ x 15/16″.
Below : The larger movement with striking mechanism.

PLATE 55.
Ship's Bell Clock. Festival of Britain, 1951.



This picture of the camera gives an idea of the problem of finding space for the clock. The clock can be recognised by the fixing knob.



The time counter on the right projects into the camera. The other is for checking.

PLATE 56.

Charles Frodsham & Co. Ltd. Camera Timer.

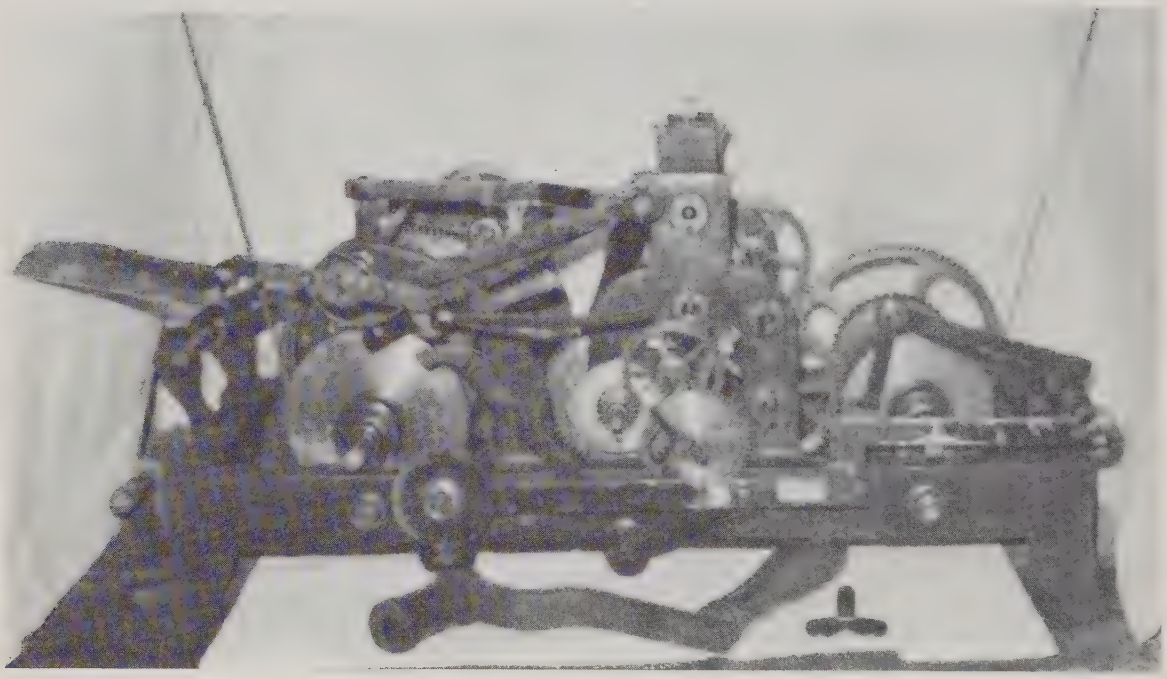


PLATE 57.

The small turret clock at Blue Mills, Witham, Essex.

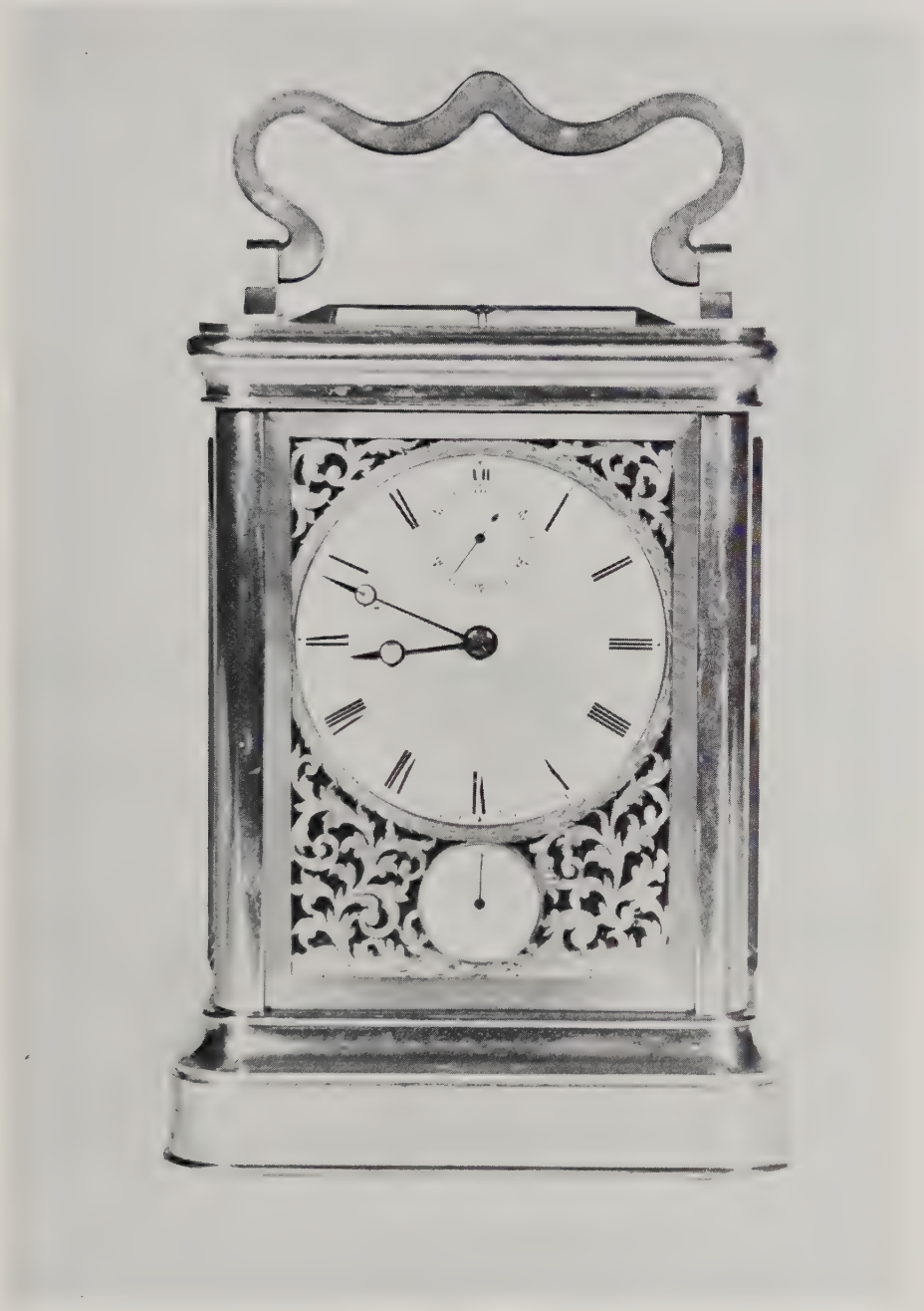


PLATE 58.

Chas. Frodsham, 84 Strand. No. 1089. Carriage clock with detent escapement fusees and up & down mechanism. Striking and repeating on a gong.

PLATE 59.

Charles Frodsham carriage clocks.

Left : No. 20766. Alarm. 115 New Bond Street

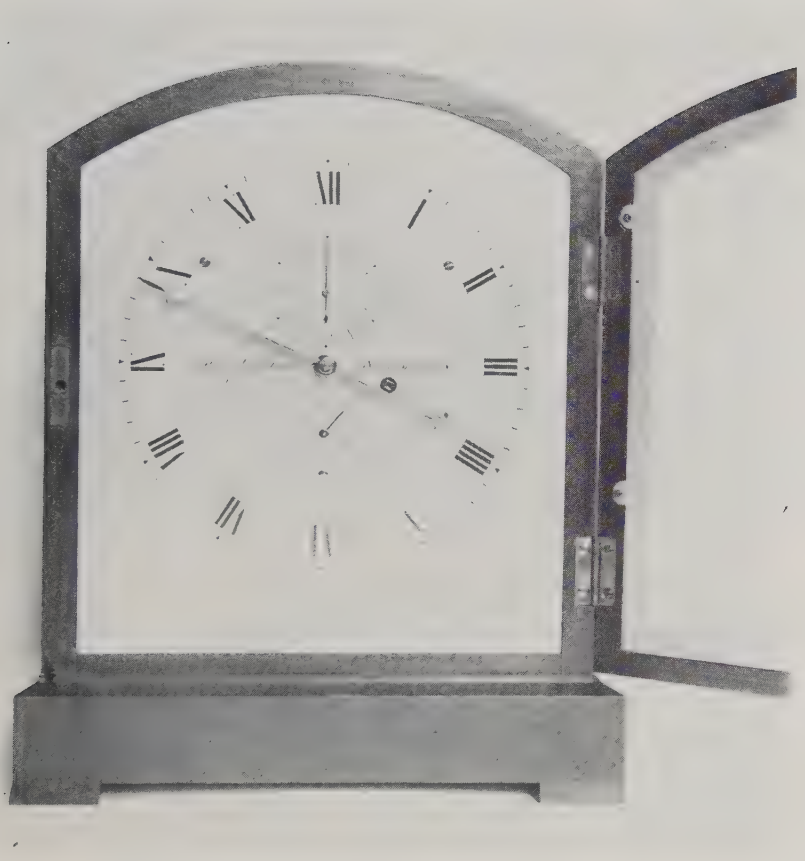


PLATE 60.

Chas. Frodsham. 27 South Molton Street. Small mantel clock No. 2469. Up & down mechanism. Note the front winding.

PLATE 61.

Two examples of mantel clocks with quarter striking and up & down mechanism in addition to the calendar work. Signed 'Frodsham'.

PLATE 62.

Charles Frodsham Carriage Clock No. 1560.

Detent escapement and Frodsham balance which is a modification of his ' Double compound micrometric equation balance ' described in the 1862 International Exhibition catalogue.

Reproduced by courtesy of Peter Bonnert.

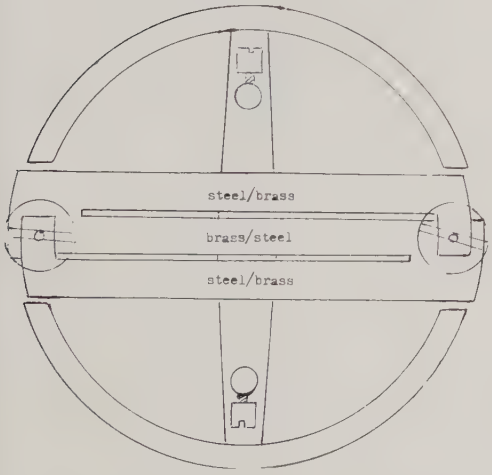


PLATE 63.

The Frodsham Balance. Another variation. Diagram to illustrate the type of balance to be found in marine chronometer No. 3593. The cut away balance rim allows the compensation bars to move freely downwards as well as upwards. In No. 3597 the rim is not cut away.

PLATE 64.
The Trade Sign outside 173 Brompton Road prior to the alterations in 1959.

PLATE 65.
Albert Ernest Rutherford.

PLATE 66.
Robert Benson North.

PLATE 67.
Philip Clowes with Sir David and Lady Yule.

PLATE 68.
173 **Brompton Road** following the extensive alterations in 1959. Note the Trade

PLATE 69.
173 Brompton Road. The new interior in 1959.

PLATE 70.

173 Brompton Road. The opening of the greatly improved premises was performed by Dame Alicia Markova on October 6th 1959. Left to right: Frank Leslie Thirkell, Dame Alicia Markova, Arthur Cover and his son, Alan Cover.

PLATE 71.
Charles Frodsham No. 8645.
Detent. Duo-in-uno balance spring.
British Museum.

PLATE 72.
Charles Frodsham No. 01316.
Independent centre seconds. Up & down.
Keyless. British Museum.

PLATE 73.
Charles Frodsham No. 01191.
Arnold, Chas Frodsham on the dial. Full plate.
Lever. Dust cap. British Museum.

PLATE 74.
Arnold, Charles Frodsham No. 03230.
Independent centre seconds. Key wind. Hand
set from back plate. Two going barrels.
British Museum.

PLATE 75.
Charles Frodsham No. 01380.
Fixed winder on fusee square.
Set hands at centre. Spring
detent. Up & down. H.M. 1869.
British Museum.

PLATE 76.
Charles Frodsham No. 03503.
Free sprung. Duo-in-uno.
Detent. Repeater.
British Museum.

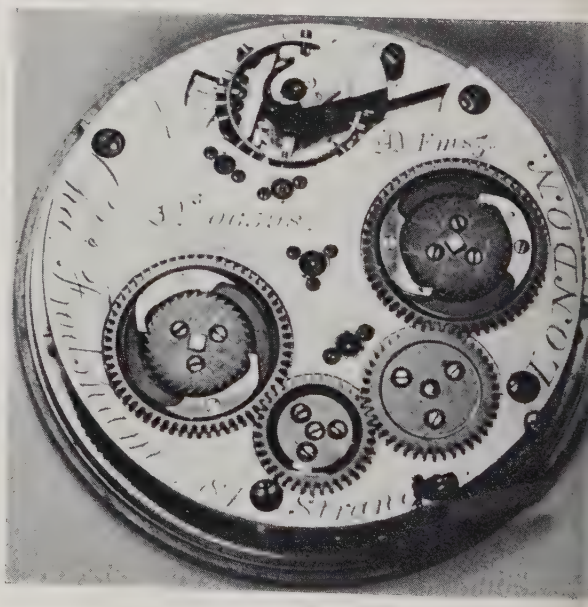


PLATE 77.
Charles Frodsham No. 06398
Free-sprung. 8-day.Lever.
Two going barrels.
British Museum.

PLATE 78.
Charles Frodsham No. 03529.
Reversed Fusee. Free sprung
'fecit 1868' on bottom plate.

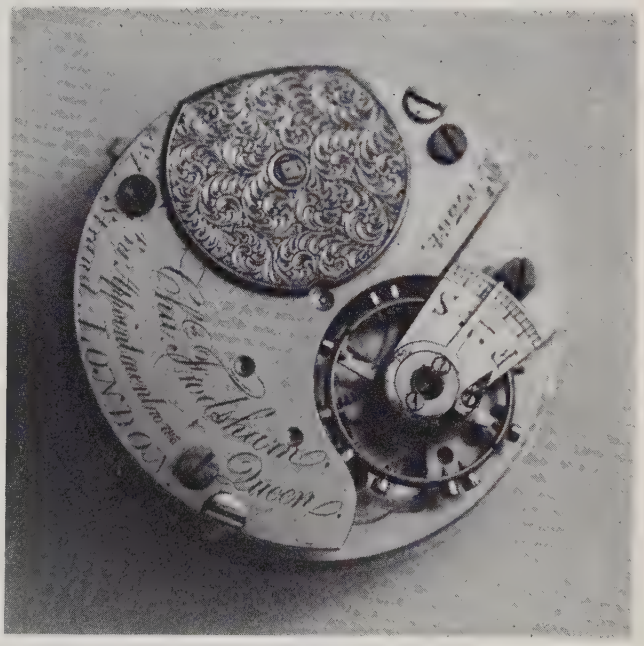


PLATE 79.
Charles Frodsham No. 07364.
Small lady's watch. Keyless. Going barrel.
Engraved raised portion over the barrel.

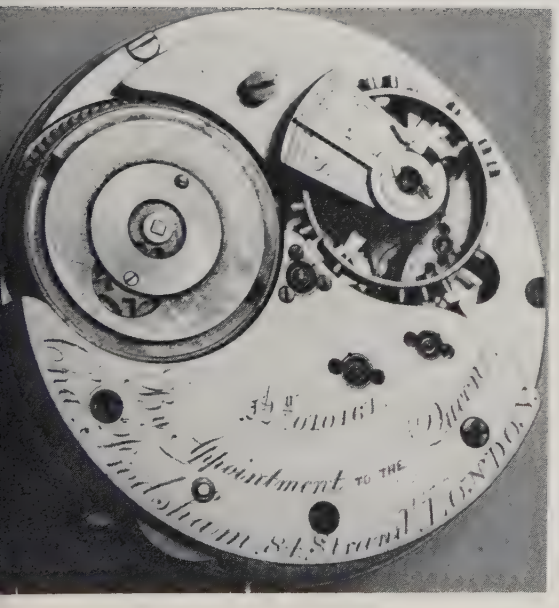


PLATE 80.
Charles Frodsham No. 010161.
Note the hanging barrel and
the Maltese Cross stop-work.

PLATE 81.
Charles Frodsham No. 02418. Minute repeating pocket chronometer with micrometer regulator. Up & down. British Museum.

PLATE 82.
No. 02418.
The Mechanism under the dial.
British Museum.

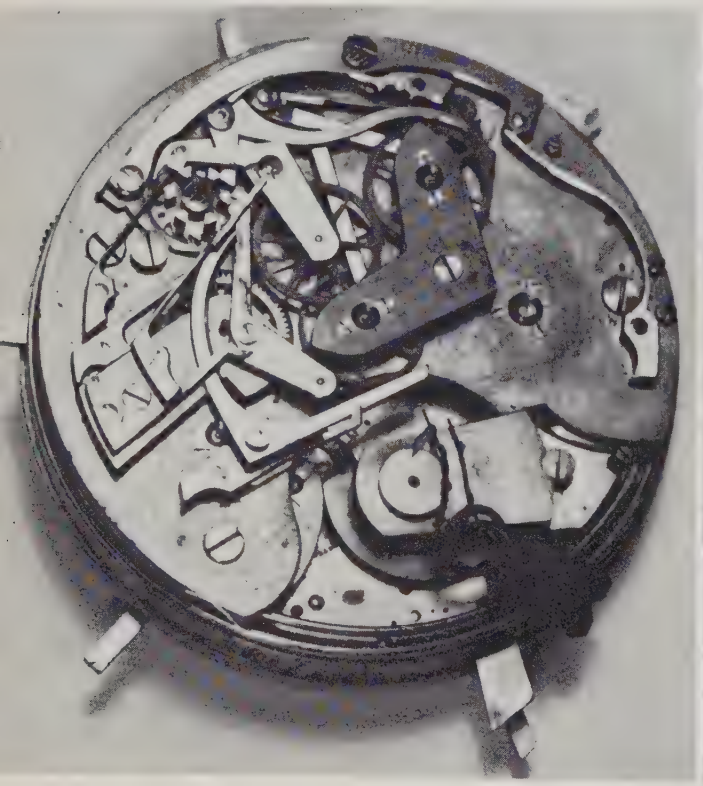


PLATE 83.
Charles Frodsham. No number. Two views of an unfinished perpetual calendar watch with phases of the moon and repeating work. British Museum.

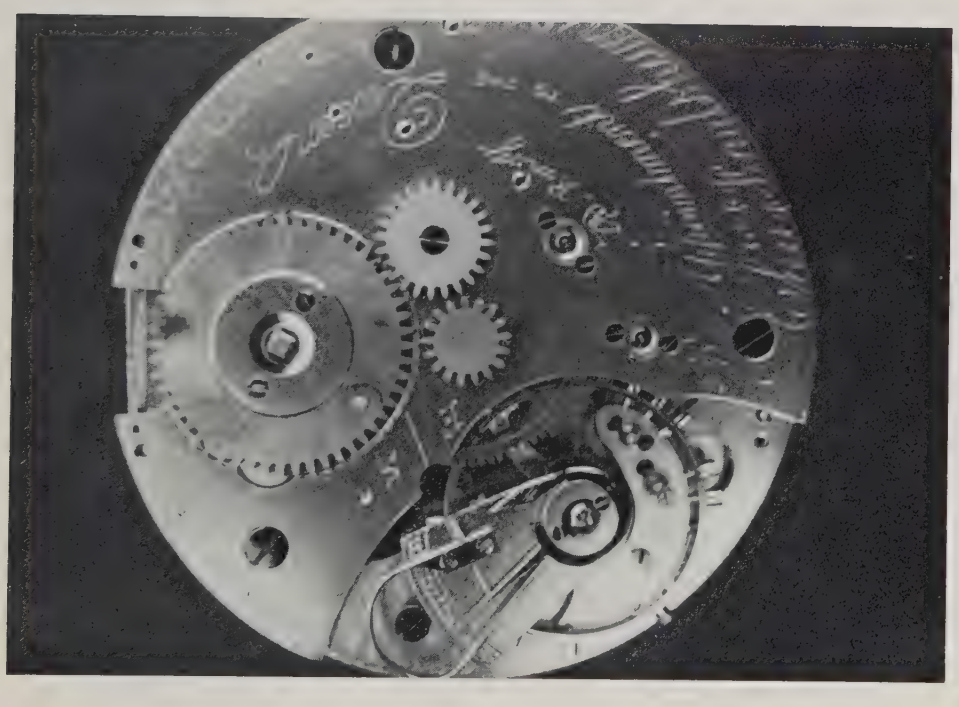


PLATE 84.

Chas. Frodsham, 84 Strand, London. No. 07820. Minute and seconds chronograph. Nicole keyless work. H.M. 1889.

PLATE 85.
Charles Frodsham No. 02317.
Centre-seconds. British Museum.

PLATE 87.
Charles Frodsham No. 10092.
H.M. 1947. Silver dial. Unfinished.

PLATE 86.
Charles Frodsham No. 03520. Double balance spring, reversed fusee. Spring banking. Up & down indicator. Front plate engraved '1867'.

PLATE 88.

Chas. Frodsham, 84 Strand. No. 08157. Minute repeating clock watch. Freesprung with helical balance spring. Double roller escapement.

PLATE 89.

Chas. Frodsham, 115 New Bond Street. No. 09190. 6 minute tourbillon.
Made by Nicole Nielsen & Co. in 1907 at a cost of £52.

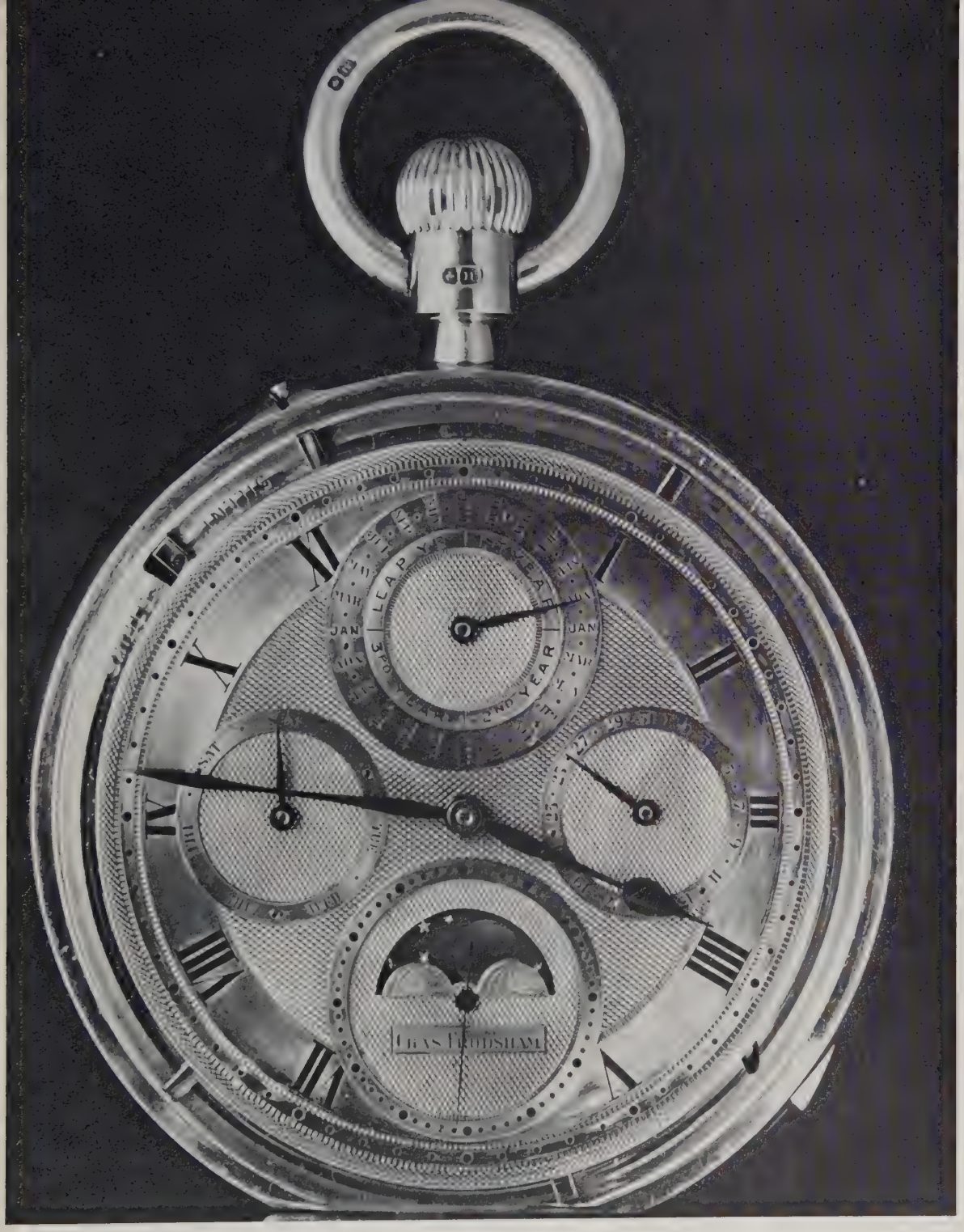


PLATE 90.

Chas. Frodsham, 27 South Molton Street. No. 09572. Made in 1916 by Nicole Nielsen. A minute repeating clock watch with perpetual calendar and showing the days of the week, the day of the month, the month, and the year and the phases of the moon. Minute revolving tourbillon with lever escapement.

PLATE 91.
Chas. Frodsham, No. 09572, to show the tourbillon.

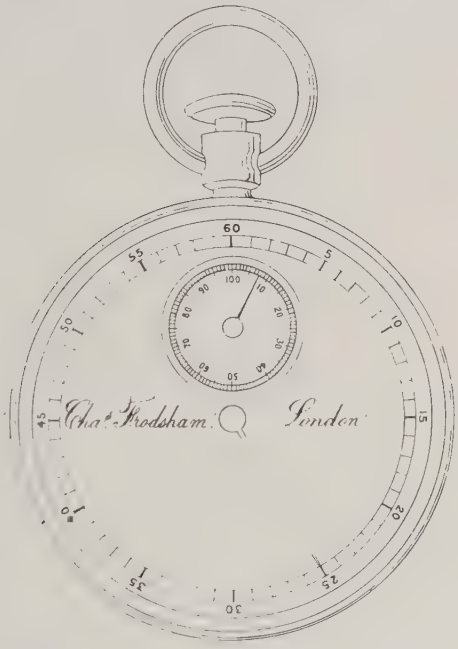
Charles FRODSHAM & Co. Ltd.

WATCHMAKERS BY APPOINTMENT TO H.M. THE KING

Holders of the large Gold Medal "Praemia Digno" from the Czar of Russia for services rendered to the great Russian Survey.

Only address: 27, SOUTH MOLTON STREET, LONDON, W.

(removed from 115, New Bond Street, London)



Quick-Acting MICROMETER CHRONOGRAPH "Time of Flight" Instrument, as supplied to H.M. Government. Records the 100th part of a second. Nickelled Case, Silvered Dial. This instrument is extremely accurate for short trials (up to 60 Seconds) and is used for timing the flight of projectiles or for any short trials, for which purposes it has been found most useful. The Illustration shews the exact size.

Price £30-0-0

PLATE 92.
Time of Flight instrument.

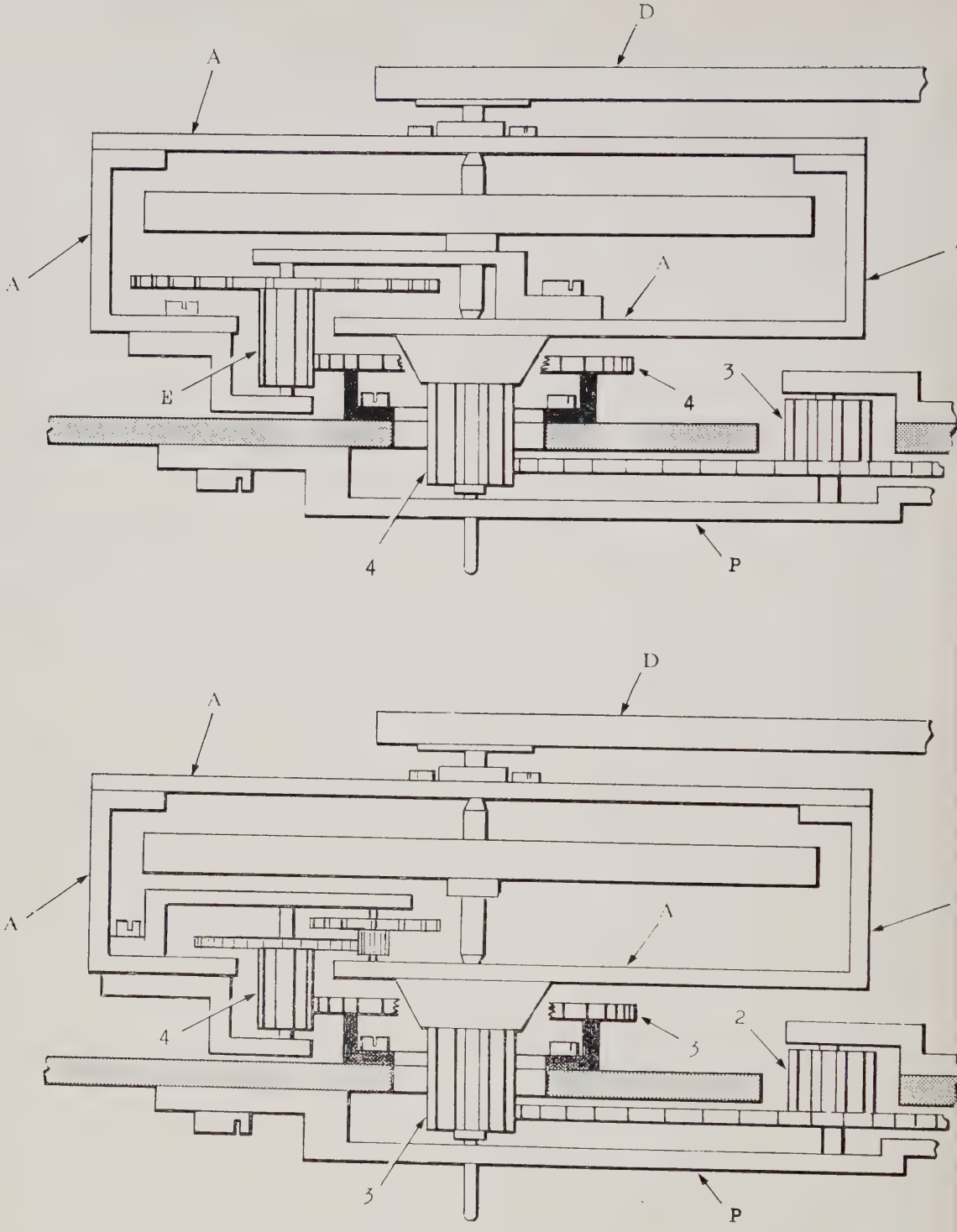
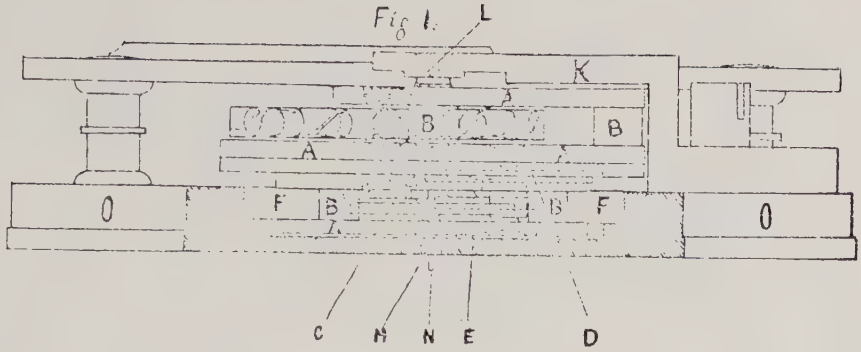


PLATE 93.

Breguet Tourbillons. Above : 1 minute type. Below : 4 or 6 minute. By the courtesy of George Daniels. Modifications of his splendid drawing in *Breguet*. Diagramatic only.

A = carriage. 2 = 2nd wheel or pinion. 3 = 3rd wheel or pinion. 4 = 4th wheel or pinion.



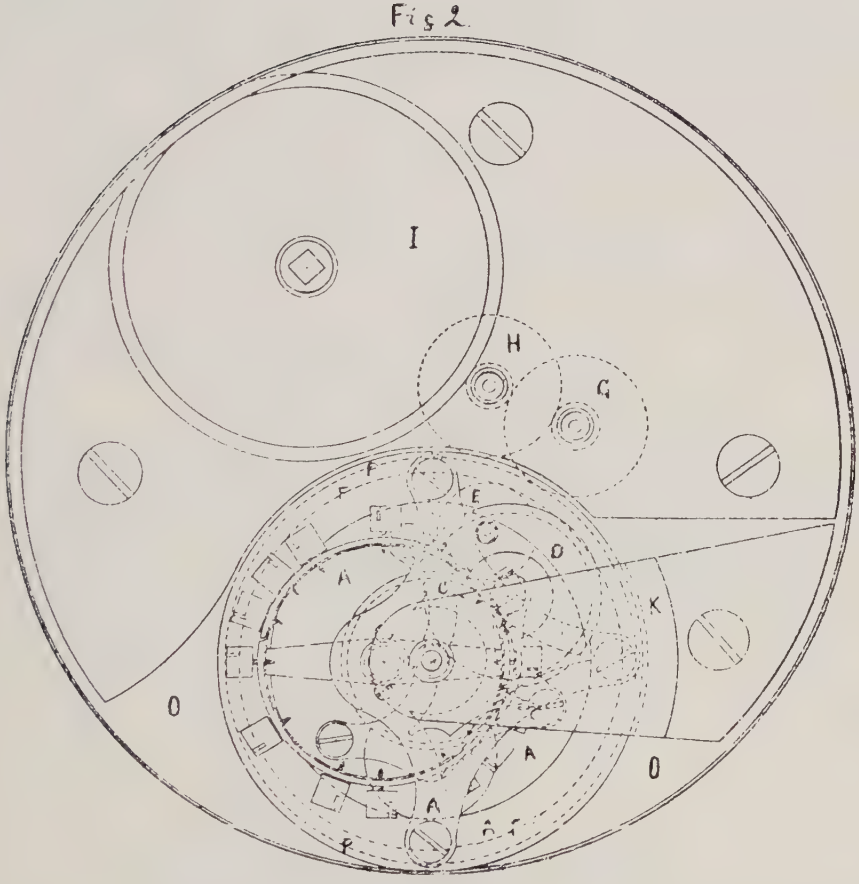
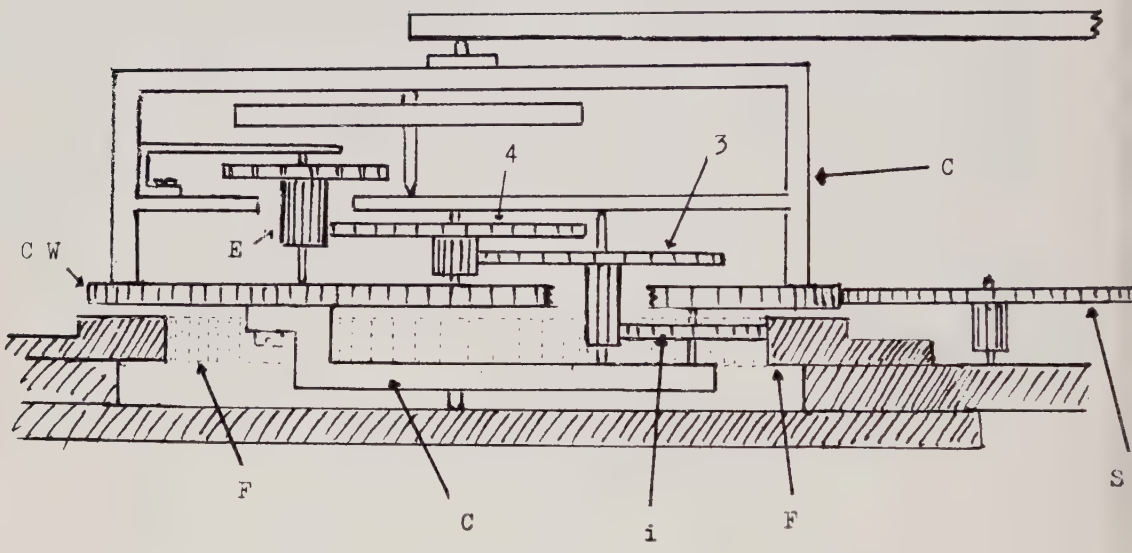


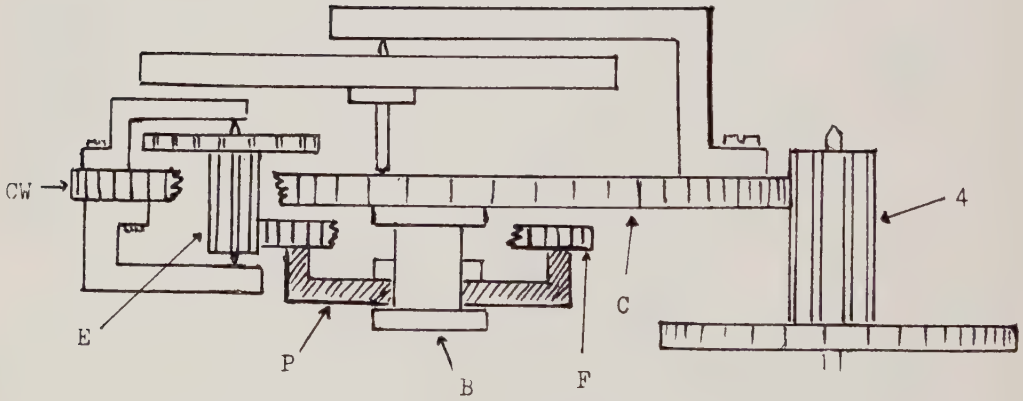
PLATE 94.

Andrew Taylor's Patent No. 16,623. A.D. 1895.

C = 4th wheel. D = 3rd wheel. E = idle wheel. F = internally cut annular wheel. G = supplementary centre wheel. H = centre wheel. A = carriage.



A. Taylor. Tourbillon 60 minutes



R.B. North. Tourbillon 4 or 5 minutes

PLATE 95.

Diagrams to clarify the patent illustrations.

2 = 2nd (centre) wheel or pinion. 3 = 3rd. 4 = 4th. B = boss. C = carriage. CP = carriage pinion. CW = carriage wheel. E = escape. F = fixed. i = intermediate wheel. P = pillar plate. S = supplementary.

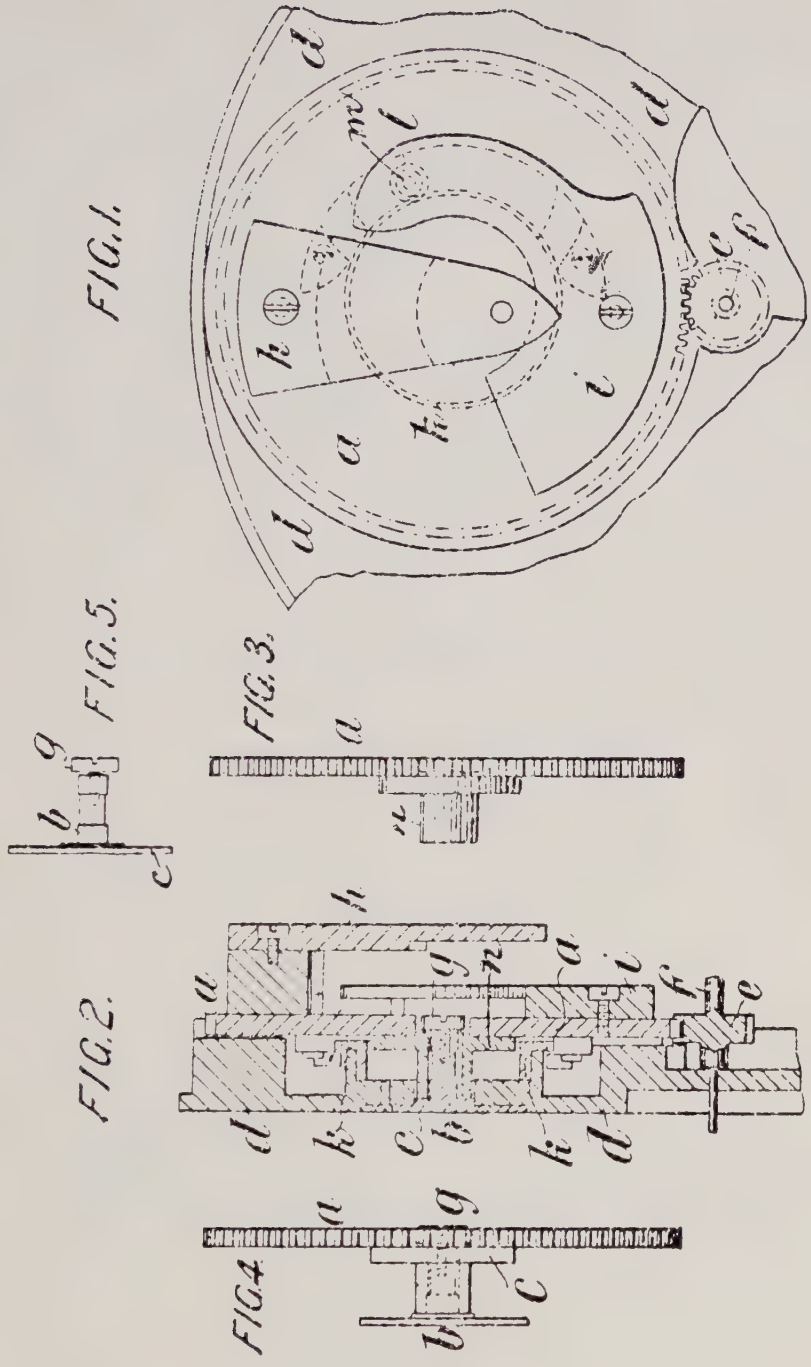


PLATE 96.

R. B. North's Patent No. 6737. A.D. 1903.

a = revolving platform with annular teeth. b = central boss. d = pillar plate. f = 4th pinion. k = fixed wheel. l = escape pinion.

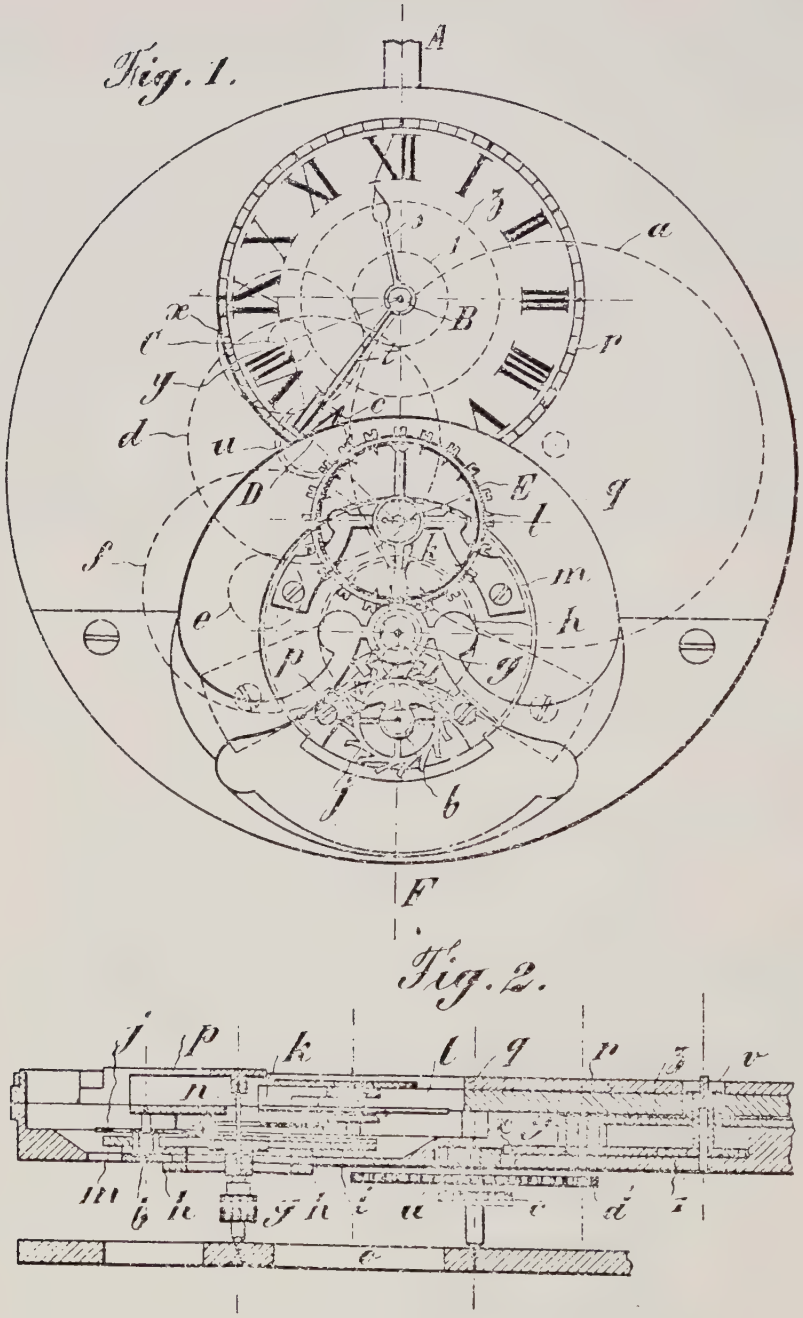
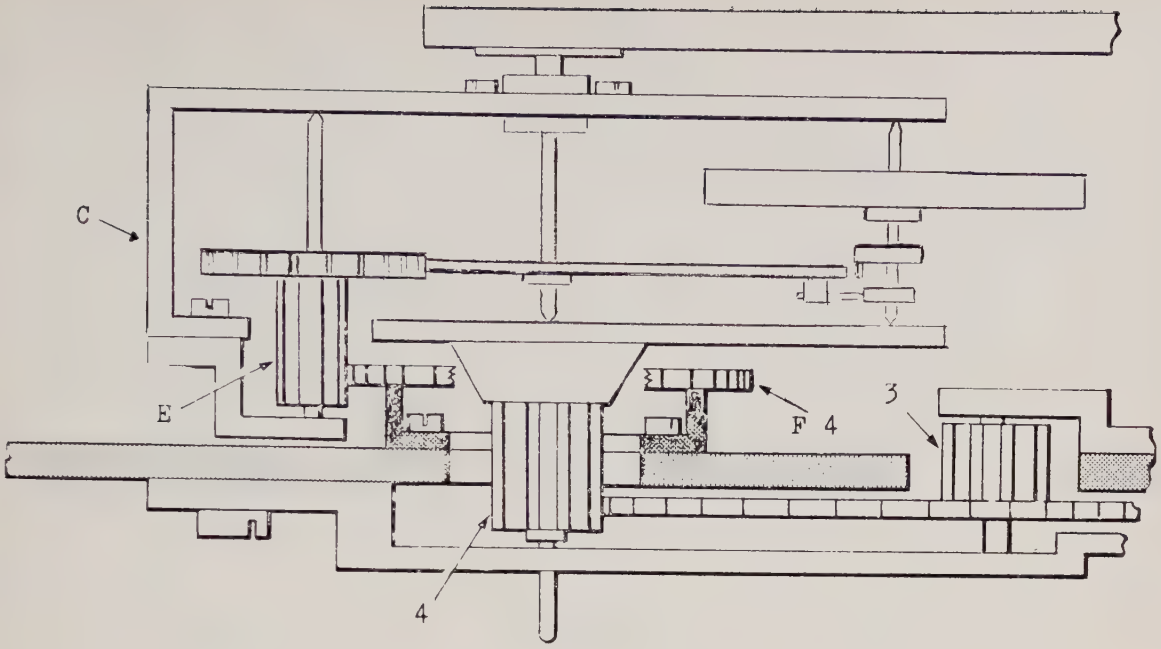


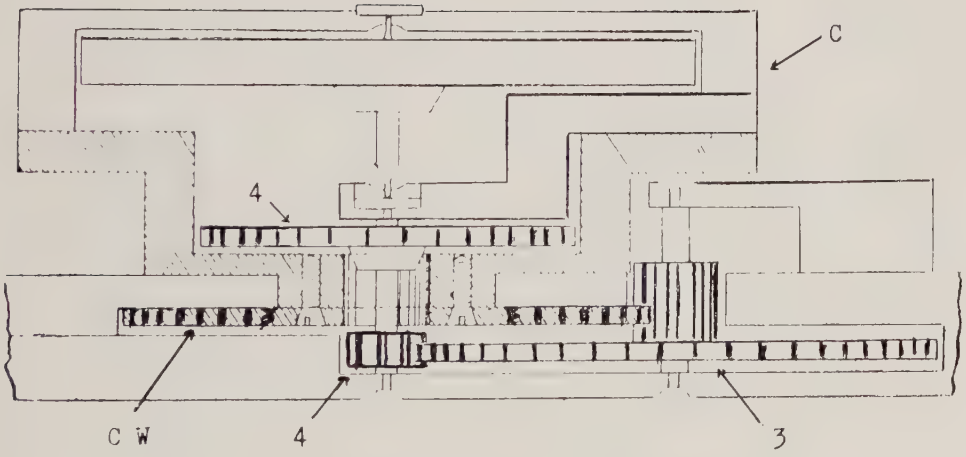
PLATE 97.

Joseph Burtin's Patent No. 7888. A.D. 1905.

a = barrel. b = escape wheel pinion. c, d, e, f, g, h = intermediate wheels and pinions. h is a fixed wheel.



J. Burtin. Tourbillon 1 minute

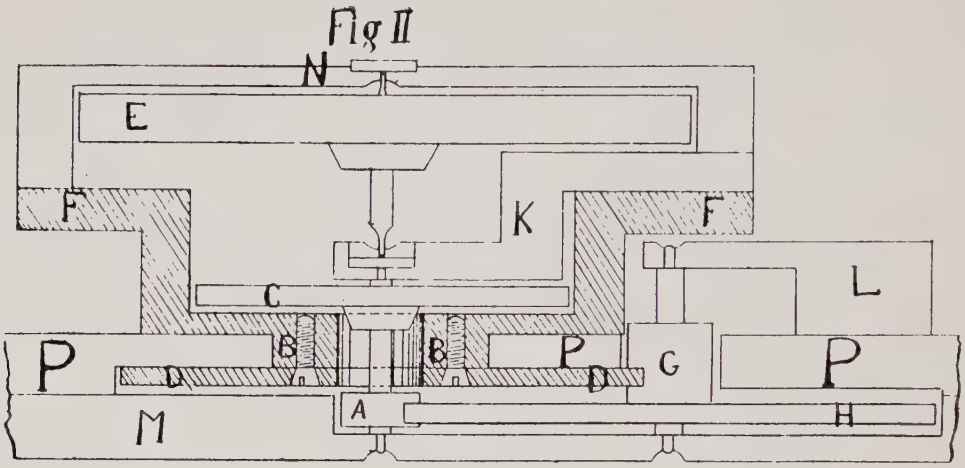


B. Bonniksen. Karrusel. 52½ minutes

PLATE 98.

Diagrams to clarify the patent illustrations.

2 = 2nd (centre) wheel or pinion. 3 = 3rd. 4 = 4th. C = carriage. CP = carriage pinion = CW = carriage wheel. E = escape. F = fixed.



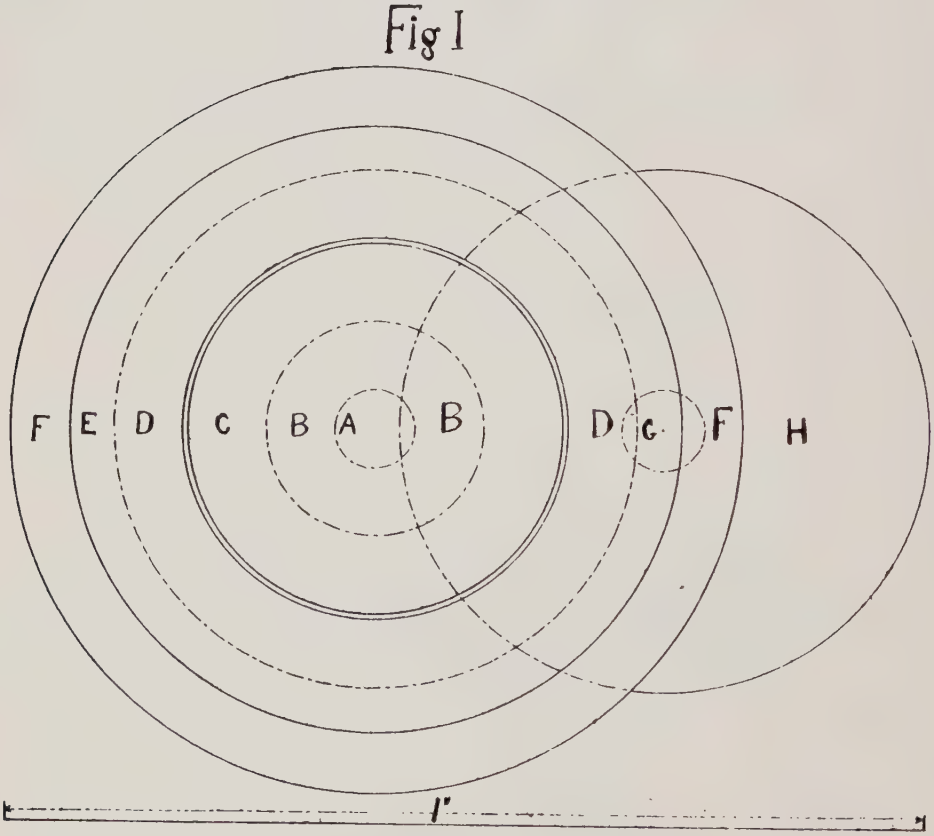


PLATE 99.

B. Bonniksen's Patent No. 21,421. A.D. 1892.

A = 4th pinion. C = 4th wheel. G = 3rd pinion. H = 3rd wheel. D = wheel driven by G

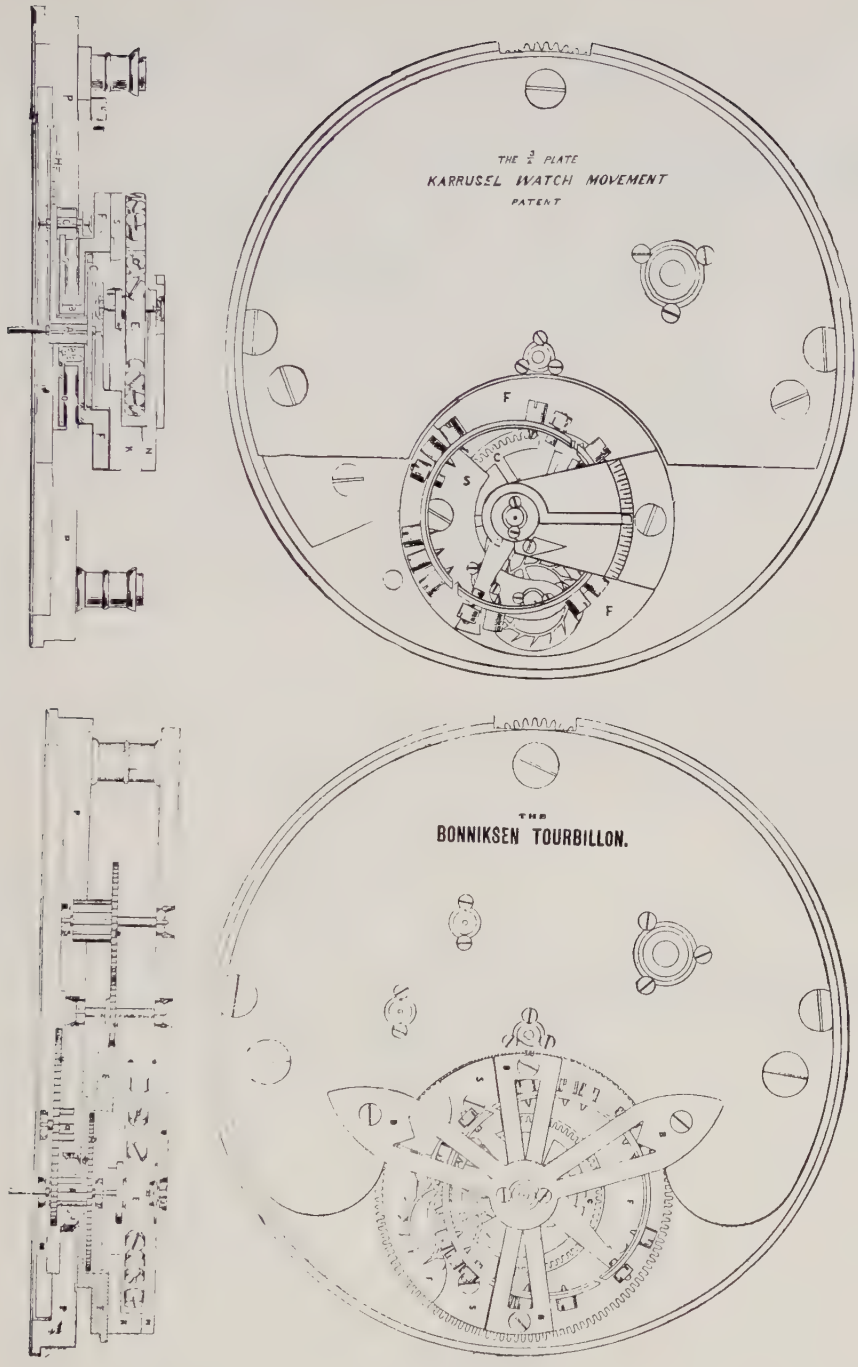
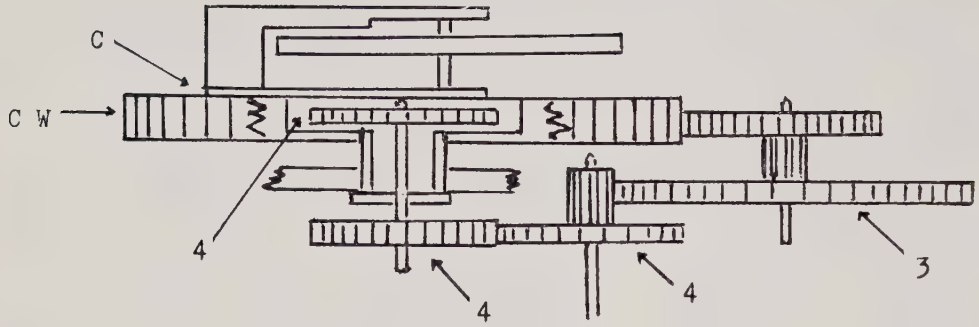


PLATE 100.

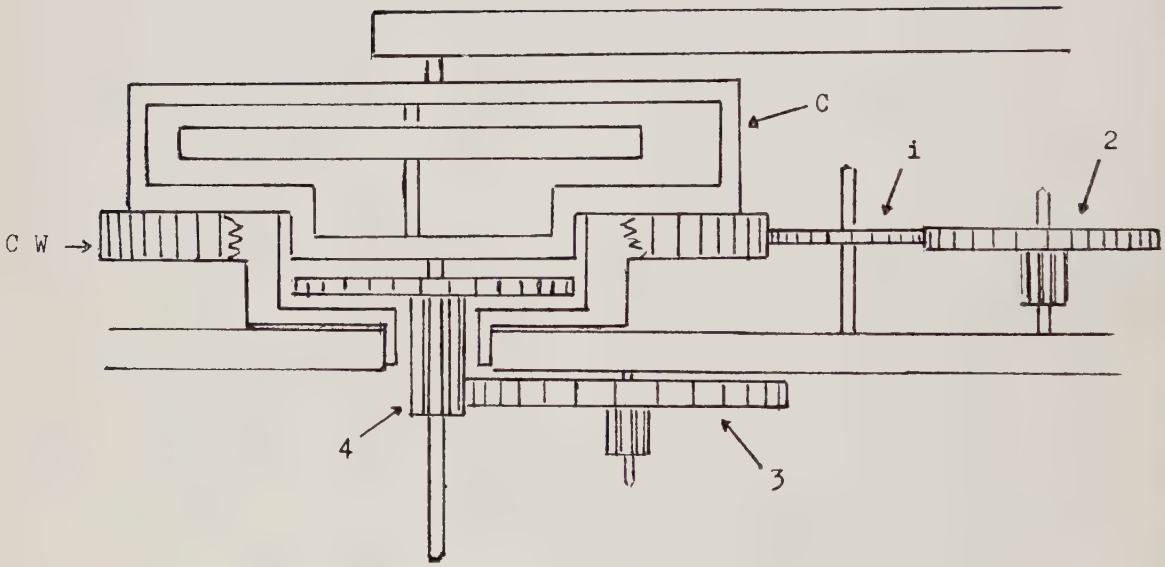
Two Bonniksen Karrusels.

Above: The 34 minute type. Centre Seconds.

Below: The 39 minute variety. So-called "Tourbillon".



B. Bonniksen. Centre seconds Karrusel. 34 minutes



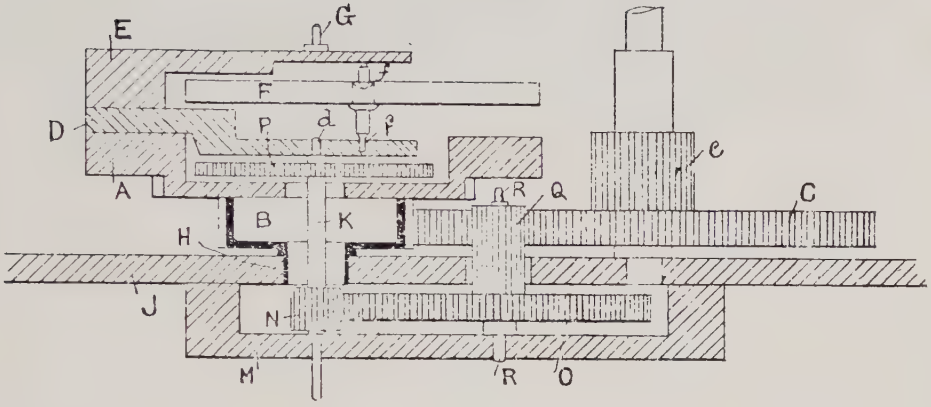
B. Bonniksen 'Tourbillon'. Karrusel 39 minutes.

PLATE 101.

Diagrams to clarify the drawings.

2 = 2nd (centre) wheel or pinion. 3 = 3rd. 4 = 4th. C = carriage. CP = carriage pinion. CW = carriage wheel. E = escape. F = fixed. i = intermediate wheel.

FIG. 1.



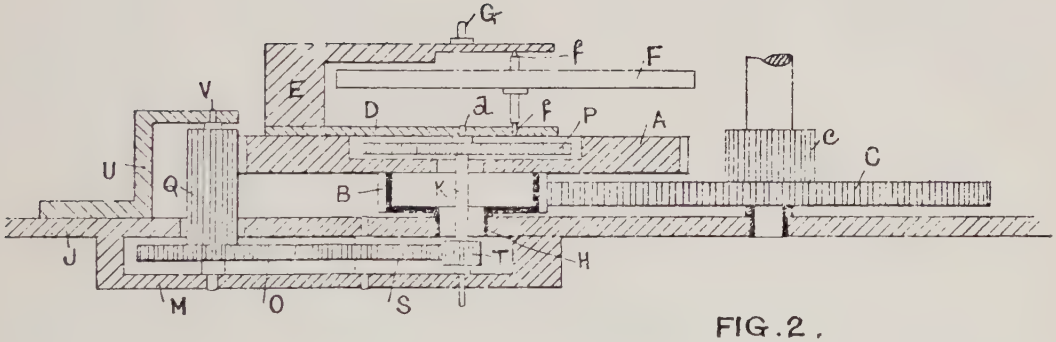


FIG. 2.

PLATE 102.

W. & E. A. Holland. Patent No. 20,235. A.D. 1902.

C = centre wheel. Q = 3rd pinion. O = 3rd wheel. N = 4th pinion. P = 4th wheel.

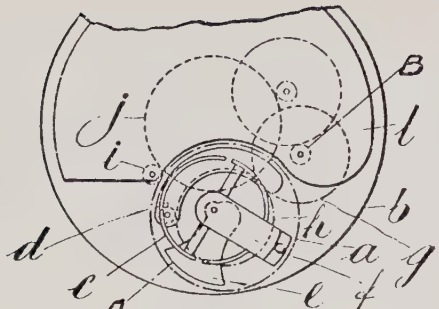


Fig. 1

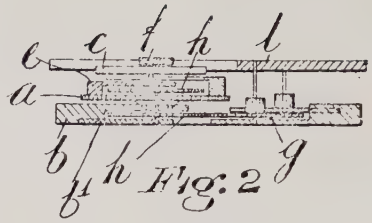


Fig. 2

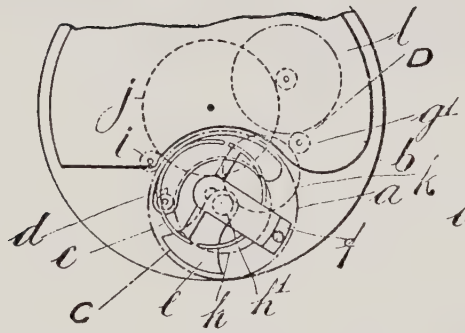


Fig. 3

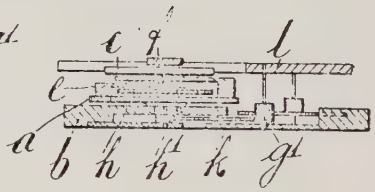


Fig. 4

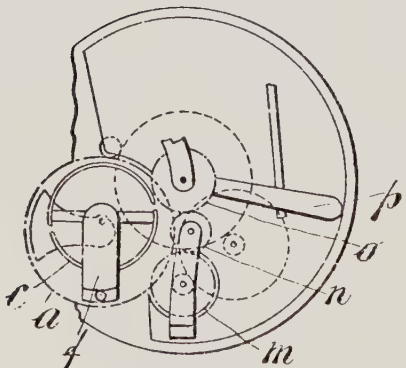


Fig. 5

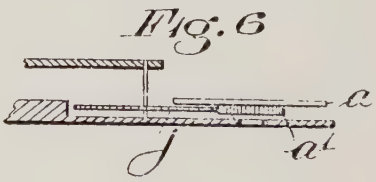
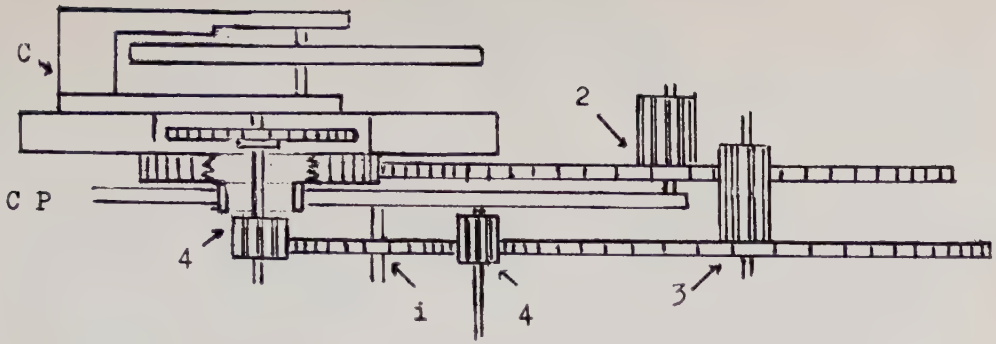


Fig. 6

PLATE 103.

W. H. Douglas' Patent No. 6858. A.D. 1906.

Fig. 1 using one intermediate wheel. Fig. 3 has two idle wheels. Fig. 5 as applied to a chronograph. d = escape pinion. g = 4th wheel. h = idle wheels.



W.H. Douglas. Karrusel 39 minutes

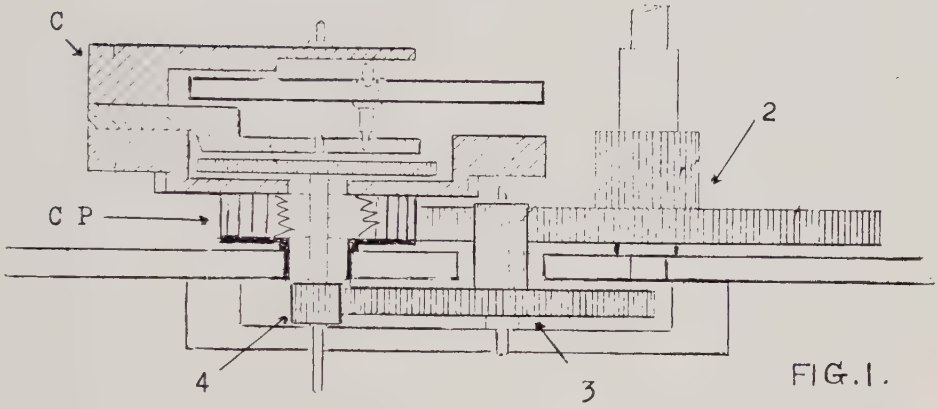


FIG.1.

29 minutes

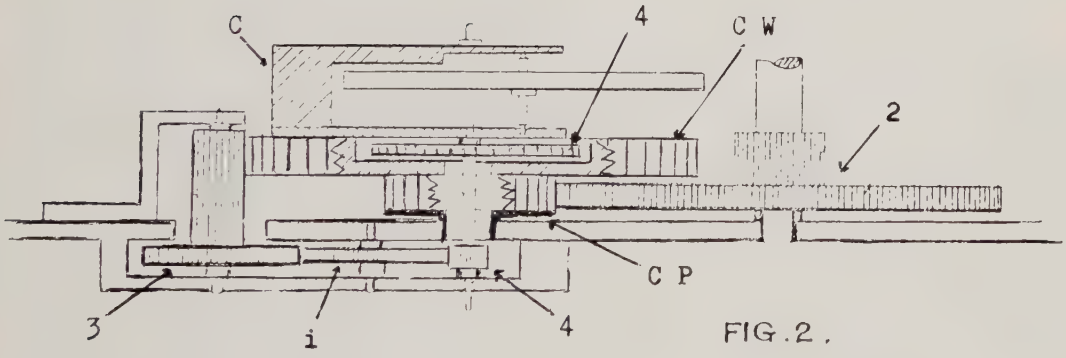


FIG.2.

W. & E.A. Holland. Karrusels

PLATE 104.

Diagrams to Clarify the Patents.

2 = 2nd (centre) wheel or pinion. 3 = 3rd. 4 = 4th. C = carriage. CP = carriage pinion. CW = carriage wheel. E = escape. F = fixed. i = intermediate wheel.

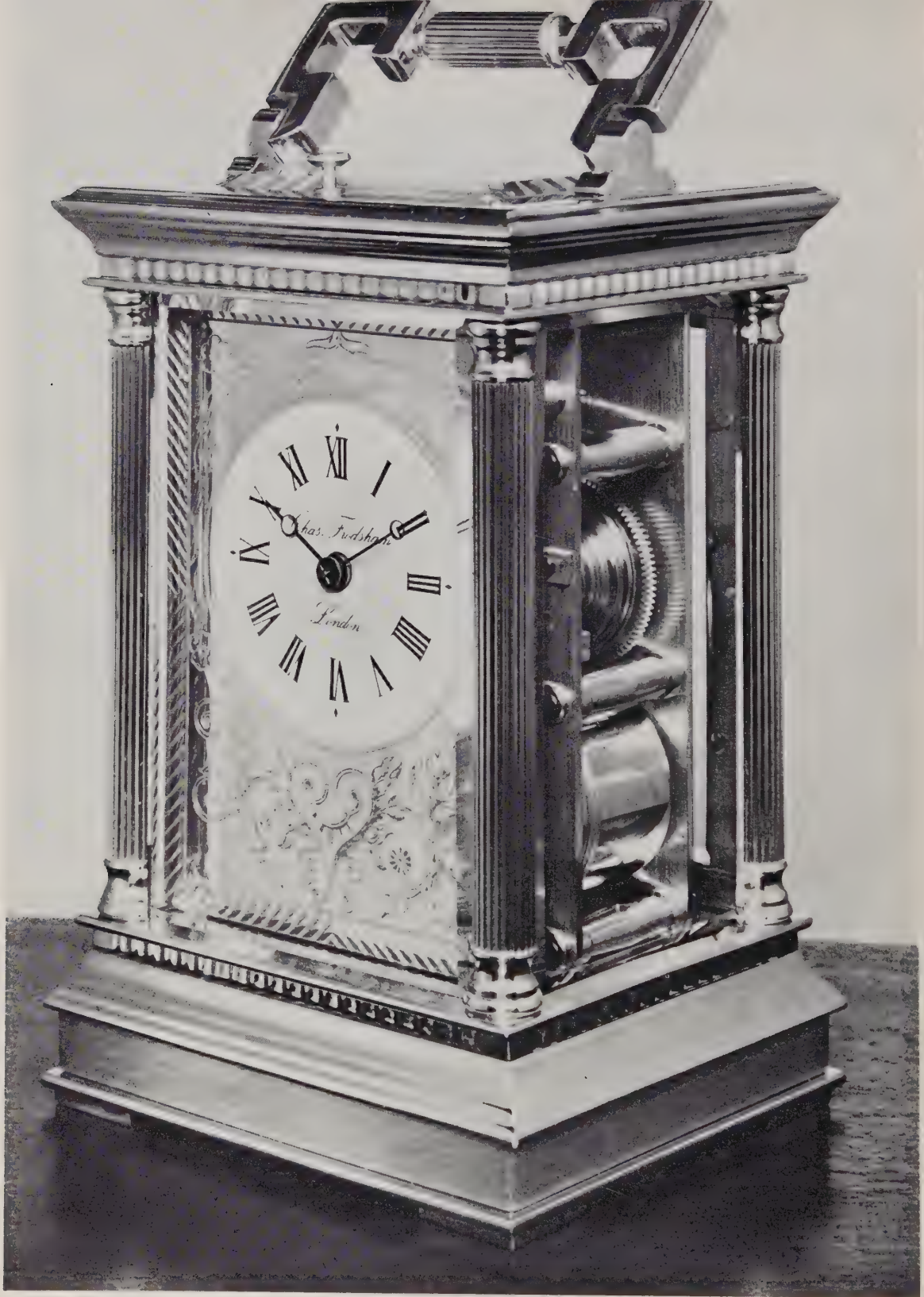


PLATE 105.

Charles Frodsham & Co. Ltd. Standard Corinthian fusee striking and repeating model. In production, 1980.

PLATE 106.

Charles Frodsham & Co. Ltd. Silver clock for the Queen Mother's 80th birthday. In production, 1980.

SPECIAL INDEX

NUMBERING

In this Index individual clock and watch numbers are given wherever possible, but in addition groups of numbers (in bold type) are also to be found, so that when consulting this Index please examine the group numbers as well as the individual ones.

Page numbers in bold type indicate the number of the page on which a plate is to be found.

Arnold, John Roger
Marine
No. 217. 27.
No. 255. 82.
No. 326. 26.
No. 338. 83.
No. 366. 103.
No. 367. 26.
No. 369. 25, 26.
No. 377. 26.
No. 404. 26.
No. 412. 83.
No. 413. 289.
No. 417. 289.
No. 451. 82, 101.
No. 497. 26.
No. 523. 25, 26.
No. 548. 149.
No. 570. 29.
No. 578. 288.
No. 943. 89, 91.
Pocket
No. 2. 27.
No. 14. 26.
No. 25. 25, 26.
No. 28. 289.
No. 1897. 26.
No. 2109. 26, 27.
No. 2151. 25.

Arnold, Frodsham & Co., Liverpool.
Pocket
No. 12011. 79.
No. 21986. 79.

Baker
Marine
No. 681. 314.
No. 864. 315.
No. 986. 315.
No. 1014. 315.

Barraud
Marine
No. 482. 102.
No. 982. 102.

Cole, Frodsham, Arnold
Pocket
No number. 104, 105.
No. 1 N.S. 105.

Cotterell, Thomas
Marine
No. 460. 32.
No. 311. 33.

Dent
Deck Watch
No. 43109. 294, 299, 315, 316.
No. 43110. 294, 299, 315, 316.
Marine
No. 2. 29.
Regulator
No. 587. 86.

Earnshaw
Marine
No. 549. 80.
No. 815. 25.
No. 1024. 25.

Guy
Marine
No. 1410. 32.

Finer & Nowland
Marine
No. 281. 26.

French
Marine
No. 3227. 29.
No. 3233. 29.
No. 3271. 29.
No. 3290. 29.
No. 3292-3296. 29.
No. 4214. 29.

Frodsham & Baker
Marine
No. 2503. 244.
No. 6048. 244.
No. 6068. 315.
Nos. 6068-6223. 269, 270.
No. 6149. 315.
No. 6160. 315.
No. 6188. 316.
No. 6203. 316.
No. 6242. 244.
No. 7163. 316.
Pocket
No. 1236. 17.
No. 7431. 244.
No. 8240. 244.

Frodsham & Keen
Marine
No. 2733. 282.
No. 2796. 60.
No. 2798. 245.
Nos. 3029-3137. 60.
Nos. 3833-3893. 282.
No. 3835. 269.
No. 3836. 269.
Nos. 3838-4080. 59, 60.
No. 3847. 317.
No. 3853. 317.
No. 3862. 317.
No. 3868. 269.
No. 6148. 245.
Nos. 8444-8658. 282.
No. 13270. 245.
Pocket
No. 71/9019. 245.

Frodsham, Charles
Carriage Clocks
No. AD 1/Fmss. 142.
No. 847. 142.
No. 1089. **401.**
No. 1560. 142, **405.**
No. 2459. 173.
No. 2469. **403.**
No. 2479. **402.**
No. 20766. **402.**
Un-numbered. **404.**
Chronometer Clocks
Nos. 504-609. 265.
Nos. 2252-2459. 265.
Nos. 10066-10069. 265.

Frodsham, Charles, Arnold &
Marine
No. 1509. 269.
No. 1529. 244.
No. 1535. 244.

Frodsham, Charles
Marine
No. 1. 33, 76, 283.
No. 2. 33, 76, 77, 283.
No. 0003. 76, 283.
No. 4. 76.
No. 8. 76.
No. 0011. 283.
No. 18. 76.
No. 0019. 76, 264.
No. 40. 284.
No. 389. 284.
No. 414. 284.
No. 1348. 284.
No. 1447. 78.
Nos. 1481-10052. 266-268.
No. 1482. 284.
No. 1485. 284.
No. 1504. 76.
No. 1521. 76.
No. 1523. 76.
No. 1529. 76, 77.
No. 1540. 284.
No. 1614. 78, 244, **364.**
No. 1681. 284.
No. 1686. 285
No. 1704. 285.
No. 1715. 77, 285.
No. 1724. 78, **365.**
No. 1752. 285.
No. 1765. 285.
No. 1768. 286.
No. 1788. 286.

No. 1806. 286.
No. 1809. 286.
No. 1826. 286.
No. 1842. 286.
Nos. 1893-13270. 280.
No. 1957. 286.
No. 2066. 287.
No. 2074. 160, 287.
No. 2241. 287.
No. 2349. 287.
No. 2411. **381.**
No. 2564. 287.
No. 2655. 287.
No. 2714. 287.
No. 2715. 288.
No. 2716. 288.
No. 2741. 288.
No. 2764. 288.
No. 2767. 288.
No. 2978. 288.
No. 3022. 288.
No. 3041. 289.
No. 3139. 289.
No. 3140. 289.
No. 3148. 89, 91.
No. 3156. 289.
No. 3169. 289.
No. 3170. 289.
No. 3178. 289.
No. 3193. 290.
No. 3205. 290.
No. 3268. 290.
No. 3311. **370.**
No. 3423. 159, 290.
No. 3425. 290.
No. 3432. 290.
No. 3446. 290.
No. 3449. 291.
No. 3464. 291.
No. 3519. 291.
No. 3533. 159.
No. 3593. 291, **405.**
No. 3597. 291, **405.**
No. 4006. 87, **371.**
No. 5004. 291.
No. 5049. 244.
No. 7004. 291.
No. 10033. 244.

Deck Watch
No. 07462. 291.
No. 07463. 292.
No. 07586. 70, 292.
No. 07587. 292.
No. 07953. 292.
No. 07958. 292.
No. 07959. 292.
No. 08073. 292.
No. 08075. 293.
No. 08093. 293.

Hack Watch
No. 09627. 293.
No. 09628. 293.
No. 09629. 293.
No. 09631. 293.

Marine
No. 10047. 293.
No. 10049. 293.
No. 10054. 293.
No. 10064. 294.

Frodsham, Charles, Arnold & Pocket
No. 2379. 244.
Nos. **2838-101397.** 245.
Nos. 12692-15897. 244.
No. F/7014. 208.
No. F/7015. 208.
No. 9737. 244.
No. 36283. 244.
No. 100511. 244.
Nos. 01054-01893. 244.
No. 01669. 245.
No. 01675. 245.

Frodsham, Charles Pocket
No. 4/1891. 215, 262.
No. 2173. 244.
Nos. **2173-10092.** 245.
Nos. **2183-8214.** 274, 275.
No. 6979. 185.
No. 8645. 207, **411.**
No. 9932. 185.
No. 9950. 244.
No. 10092. 185, 244, **416.**
No. 35020. 280.
No. 60637. 244.
No. 99765. 280.
No. 101397. 93, 244.
No. 119946. 280.
No. 304925. 280.
No. 304988. 280.

No. 304989. 280.
Nos. 01289-010321. 245-246.
Nos. 01398-010295. 275-280.
Nos. 02033-07502. 263-64.
Nos. 05501-09315. 255-262.
Nos. 07462-08959. 270, 271.
Nos. 08300-010295. 215-218.
No. 01191. 207, **411.**
No. 01316. 207, **411.**
No. 01380. 208, **412.**
Nos. 01914. 244.
No. 02317. **416.**
No. 02408. 106.
No. 02418. 207, **414.**
No. 02669. 208.
No. 03230. 207, **411.**
No. 03503. 207, **412.**
No. 03520. 208, **416.**
No. 03526. 106.
No. 03529. **413.**
No. 03530. 208.
No. 05872. 208.
No. 06018. 209.
No. 06398. 207, **412.**
No. 07364. **413.**
No. 07629. 209.
No. 07820. 208, **415.**
No. 08157. 208, **417.**
No. 08231. 206.
No. 08500. 211.
No. 08501. 211.
No. 09182. 209.
No. 09190. **418.**
No. 09572. 209, **419, 420.**
No. 09642. 210.
No. 010012. 206.
No. 010161. **413.**
No. 010209. 206.
No. 010321. 244.
No number. 207, **411.**

Ship's Clocks
No. 922. 142.
No. 1348. 142.

Regulators
No. 1165. 142.
No. 1607. 142.
No. 1870. 142.
No number. 142.

Frodsham, Charles Mill
Marine
No. 3/3250. 151, 270.
No. 3/3308. 151, 152, 316, **380, 381.**
No. 4/3348. 151, 270, 316.
No. 3362. 151, 270.

Frodsham, G. E.
Pocket
No. 191-226. 280.
Nos. 2505-67003. 245.
Nos. 3447-24987. 281.
No. 6019. 21, **346.**
No. 6524. 269.
No. 6950. 21, **354.**

Frodsham, Henry
Marine
No. 1. 27, 52, 317
No. 192. 52.
No. 454. 60.
Nos. 873-1830. 52.
No. 1502. 32.
No. 1600. 32.
No. 1681. 60.
Nos. 1991-4956. 245.
No. 2100. 317.
No. 2703. 269.
Nos. 3029-3137. 60.
No. 3093. 58, 245.
Nos. 3838-4080. 59, 60.
No. 13270. 60.
Pocket
No. 20377. 62, 245, 247.
No. 46267. 62, 245.
Deck Watch
No. 46267. **358, 359.**

Frodsham, William, Red Lion Square
Pocket
No. 568. 11.
No. 850. 11.
No. 951. 11.
No. 1122. 11.
No. 2579. 11.

Frodsham, William, Liverpool
Pocket
No. 1784. 56.

Frodsham, William Edward
Marine
No. 1. 26, 28, 52.
No. 2. 317.

Hutton, John
Marine
No. 138. 160, 161.

Lancaster
Marine
No. 552. 27.
No. 566. 27.

McCabe
Marine
No. 167. 29.
No. 187. 29.
No. 521. 288.

McCabe & Strachan
Marine
No. 134. 29.

Molyneux
Marine
No. 1263. 33.
No. 5174. 91.

Molyneux & Cope
Marine
No. 405. 26.

Murray
Marine
No. 518. 27.
No. 555. 29.
No. 620. 29.
No. 816. 27.

Parkinson & Frodsham
Carriage Clocks
Nos. 114-3061. 67.

Marine & Pocket
Nos. 105-3943. 244.

No. 108. 294.
No. 145. 29.
No. 146. 29.
No. 228. 25, 26, 27, 29, 294.
No. 251. 30.
No. 253. 25, 26, 294.
No. 254. 25, 26, 27, 29, 294.
No. 259. 25, 26, 27.
No. 276. 29.
No. 287. 294.
No. 307.(P) 30, **353.**
No. 324. 30.
No. 357. 28.
No. 384. 28.
No. 423. (P) 27, 28, 294.
No. 427-1091. 36.
No. 460. 26, 29.
No. 478. (P) **353.**
No. 493. 28.
No. 510. 27, **354.**
No. 541. (P) 295.
Nos. 541-2955. 268.
No. 543. (P) 29.
No. 557. 295.
No. 564. 30.
No. 571. 31, 295.
No. 594. 29.
No. 620. 30.
No. 649. 27, 295.
No. 699. (P) 28, 29, 30, 295.
No. 701. (P) 28, 295.
No. 729. 30.
No. 730/17290. 244.
No. 741. (P) 28, 296.
No. 745. 34.
No. 750. 30, 296.
No. 771. 29.
No. 773. 296.
No. 776. 34.
No. 799. (P) 28, 29, 296.
No. 838. 296.
No. 849. 296.
No. 902. 29, 296.
No. 925. 34, 297.
No. 948 (P) 28, 297.
No. 980. (P) 28, 30, 297.
No. 1042. 297.
No. 1081. (P) 31.
No. 1095. 29, 297.
No. 1152. 30.
No. 1204. 29, 298.
No. 1228. 298.
No. 1230. 30, 298.
No. 1285. 298.
No. 1329. 298.
No. 1355. 298.
No. 1454. 299.
No. 1632. 299.
No. 1701. 299.
No. 1731. 35.
No. 1750. 299.
No. 1751. 35.
No. 1770. 299.
No. 1826. 300.
No. 1848. 29.
No. 1886. 300.

No. 1887. 300.
No. 1978. 34.
No. 2061. 300.
No. 2077. 300.
No. 2106. 300.
No. 2110. 30.
No. 2111. 301.
No. 2131. 30.
No. 2146. 301.
No. 2153. 301.
No. 2154. 301.
No. 2184. 301.
No. 2200. 301.
No. 2207. 302.
Nos. 2209-4284. 268-269.
No. 2211. 302.
No. 2216. 302.
No. 2225. 302.
No. 2264. 302.
No. 2277. 302.
No. 2291. 302.
No. 2307. 302.
No. 2308. 303.
No. 2310. 30, 303.
No. 2311. 303.
No. 2312. 30.
No. 2313. 303.
No. 2322. 303.
No. 2324. 303.
No. 2335. 303.
No. 2336. 304.
No. 2357. 304.
No. 2373. 42.
No. 2382. 304.
No. 2423. 304.
No. 2496. 304.
No. 2523. 304.
Nos. 2523-7269. 71.
No. 2524. 305.
No. 2595. 305.
No. 2614. 305.
No. 2630. 305.
No. 2661. 305.
No. 2709. 30, 305.
No. 2791. 306.
No. 2955. 306.
No. 2958. 306.
No. 3642. 306.
No. 3643. 306.
No. 3687. 306.
No. 3688. 307.
No. 3697. 307.
No. 3704. 307.
No. 3705. 307.
No. 2719. 307.
No. 3876-3949. 67.
No. 3943. 307.
No. 4099. 307.
No. 4154-6450. 281.
No. 4217-4357. 254.
No. 4283. 308.
No. 4284. 308.
No. 4436. 308.
No. 4530. 308, **381.**
No. 4531. 308.
No. 4608. (P) **354.**
No. 4711. 69.
No. 5076. 69.
No. 5674. 69.
No. 5676. 308.
No. 5823. 308.

Hack Watch
No. 7272. 271.
No. 7273. 271.
No. 7365. 309.
No. 7366. 309.
No. 7367. 309.
No. 7368. 309.
No. 7369. 309.
No. 7370. 309.
No. 7371. 309.
No. 7372. 309.
No. 7373. 309.
No. 7374. 310.
No. 7375. 310.
No. 7376. 310.
No. 7391. 310.
No. 7393. 310.
No. 7394. 310.
No. 7395. 310.
No. 7396. 310.
No. 7397. 310.
No. 7398. 310.
No. 7399. 310.
No. 7400. 311.
No. 7401. 311.
No. 7402. 311.
No. 7403. 311.
No. 7404. 311.
No. 7405. 311.
No. 7406. 311.
No. 7407. 311.
No. 7408. 311.
No. 7409. 312.

No. 7410. 312.
No. 7411. 312.
No. 7412. 312.
No. 7413. 312.
No. 7415. 312.
No. 7417. 312.
No. 7418. 312.
No. 7419. 312.
No. 7420. 312.
No. 7421. 313.
No. 7422. 313.
No. 7423. 313.
No. 7424. 313.
No. 7425. 313.
No. 7429. 313.
No. 7431. 313.
No. 7433. 313.
No. 7434. 313.
No. 7435. 313.
No. 7436. 313.
No. 7437. 314.
No. 7438. 314.
No. 7440. 314.
No. 7441. 314.
No. 7442. 314.
No. 7443. 314.
No. 7444. 314.
No. 7446. 314.
No. 7447. 314.
No. 7448. 314.

Pocket (See also "Marine & Pocket")
Nos. 113-12278. 244.
Nos. 324-381477. 246, 247.
Nos. 1091-278413. 281.
No. 3852-5403. 67.
Nos. 5801-7473. 248-254.
Nos. 14989-381477. 244.
No. 2441. **381.**
No. 5458. 264.
No. 7269. **354.**

Poole
Marine
No. 3974. 62.

Porthouse
Marine
No. 7231. 307.

Smith
Marine
No. 27. 27.

Webster, Richard
Marine
No. 665. 33.
No. 679. 32.
No. 700. 33.
No. 728. 33.

Young
Marine
No. 78. 29.

SPECIAL INDEX

SHIPS

Abercrombie 298
Aboukir 302, 304
Acheron 287, 297, 298
Achilles 290, 307, 316
Acorn 285, 300
Action 299
Active 298
Admiral Washington 299
Advance 30
Adventure 29, 305
Alban 298, 300, 302
Albatross 284, 291, 297
Albermarle 318
Albury 309
Alecto 300, 302, 310, 312
Alert 285, 292, 296, 297
Alexander 24
Alexandra 291
Alna 294
Alsation 288
Amazon 302
Amphion 290, 305
Andromache 301
Antelope 286, 294, 316
Aphrodite 294
Apollo 301
Appleleaf 309
Arab 301, 305
Arabis 300, 301
Archer 306, 315
Ardent 294, 297
Arethusa 299, 305
Argonaut 286
Argus 315, 316
Ark Royal 299
Asp 284, 297
Assistance 295, 298, 315
Athol 317
Attentive 292
Atter 301
Audacious 284, 287, 291, 295
Aurora 314
Australia 303
Avenger 310
Avon 288, 300, 305, 306

Bacchanti 307, 315
Bacchus 309
Balbee 315
Barbados 306
Barfleur 289, 307
Barham 294, 314
Barracouta 287, 288, 305
Basilisk 284, 294, 295, 316
Beacon 290, 291, 298, 299, 304, 305
Beagle 29, 283, 287, 292, 294, 297, 307, 311, 317
Belleisle 288
Bellerophon 290, 307
Bellona 307, 311
Benbow 285, 290, 299, 300, 301, 314
Bermuda 297, 300, 305
Berwick 293, 308
Birkenhead 285, 293, 296
Birmingham 314
Bittern 294, 300
Black Eagle 294
Blake 287, 297, 307, 314
Blanche 287, 317
Blazer 294, 297, 298, 299, 300, 301, 303, 305, 315, 317
Blenheim 293, 299, 304
Blonde 317
Boadicea 286
Bombay 284, 300, 315
Bombay Merchant 29
Bonaventure 309, 310
Bonetta 286
Boomerang 299
Brilliant 291, 304, 305
Brisk 286, 291
Bristol 290, 297
Britannia 287, 298, 306, 315
British Lantern 312
Buckworth 283
Bulldog 289, 306
Bullfinch 289, 295
Bullfrog 287, 303
Buzzard 284, 297

Caesar 299
Caledonia 30
Calypso 288
Cameron 307
Camilla 301
Campbell 312
Canada 285, 293
Candytuft 301

Caradoc 291, 304, 309
Carnarvon 299, 315
Caroline 317
Carysfort 288, 299, 310
Castor 285, 294
Centurian 314
Cevic 312
Challenger 285, 286, 296, 298, 305, 314
Champion 286, 288, 290, 297
Chanticleer 28, 295, 296, 297
Charybdis 283, 285, 286, 297, 299
Clementina 288
Clio 296, 302, 307
Cochrane 287
Cockatrice 288, 298, 307
Colossus 287, 289, 291, 307
Columbia 298, 315
Columbine 284, 289, 300
Condor 283
Cone 312
Confidence 294, 303
Contest 312
Conqueror 285
Cordelia 291
Cormorant 293, 298
Cornwall 283, 305
Corsair 290, 298
Cossack 304, 316
Crescent 283, 312
Crocodile 285, 299
Cruizer 300
Curacoa 311, 317
Custer 301
Cyclops 284, 294, 297, 307, 312

Dahlia 311
Danae 304
Daphne 302, 315, 316
Dart 288, 305, 308
Dee 288, 298, 301, 304, 305
Defence 301
Devonshire 308
Diamond 288, 290
Dido 288, 293, 297, 299, 301, 309, 311, 313
Diligence 300, 312
Dolphin 284, 287, 307
Donegal 291
Doris 286
Dotterel 306
Dover 301
Dreadnought 299
Driver 298
Dromedary 304
Druid 299
Dryad 285, 289
Dublin 299
Duncan 285, 299, 302, 316
Durham 292
Dwarf 285, 286, 290, 305

Eagle 313
Eclair 301
Eclipse 306
Edgar 300
Edinburgh 288, 289, 298, 300, 312
Effingham 293, 311
Egeria 289, 296, 307, 308
Elk 304
Emerald 305, 310
Empress of India 302
Enchantress 294
Endeavour 293, 294
Endymion 289, 292, 297, 304, 307
Enterprise 296, 302
Erebus 30, 283, 285, 297, 301, 302, 303, 304, 305
Espiegle 285
Etna 283, 294
Euryalus 296, 297, 301
Exmouth 203, 287
Expion 305

Fairy 284, 295, 296, 297, 298
Favourite 302
Fawn 291, 294, 302, 316
Fearless 311
Ferol 292
Firebrand 302
Firefly 285, 298, 299
Firedrake 313
Flamer 299
Flinders 308
Flirt 294
Flora 306, 307, 317
Fly 284, 303, 304
Flying Fish 285, 286, 289, 294, 300, 303, 304
Foam 299
Forester 301
Formidable 285, 301
Forward 287
Fox 294, 295, 297, 306
Furious 314

Fury 26, 27, 31, 295

Gannet 284, 290, 305, 315
Garnet 290
Genista 312
Gibraltar 300
Gladiator 305
Glassy 304
Glorious 317
Gloworm 314
Goldfinch 284, 289, 316
Gorgon 298
Goshawk 297
Gossamer 296, 303, 317
Grappler 286, 318
Grasshopper 283, 286
Greenwich 293, 298, 299, 300
Grimsby 308
Griper 25, 26, 28
Growler 286
Gulnare 297

Hannibal 30, 295, 308
Harrier 289
Haughty 292
Havannah 302
Hawk 298
Hawke 285, 289, 299
Hearty 297, 301, 304, 305
Hebe 291, 310, 312
Hecate 296, 297, 298
Hecla 25, 26, 27, 35, 283, 294, 295, 296, 297, 300, 301, 302, 311, 312
Hector 301
Heliotrope 313
Herald 294, 296, 297, 305, 315, 318
Hercules 291, 294, 296, 299
Hermes 284, 292, 293, 295, 296, 305, 315
Hermione 286, 288
Hesper 300, 301
Hibernia 290
Highflyer 285, 305
Himalya 291, 304
Hindoo 30
Hindustan 301
Hiphon 300
Honolulu 297
Hood 285, 286, 313, 314
Hornet 296, 304
Hostile 311
Hotspur 307
Howe 285
Hull 316
Humber 317
Hunter 311
Huntsgreen 316
Hussar 294
Hyacinth 294
Hydra 286, 287, 294, 299, 300, 304, 305, 306

Illustrious 292
Imogene 307
Imperience 289
Inconstant 287
Indefatigable 288, 292
Industry 285, 288, 315
Inflexible 296, 299, 300, 302
Instance 288
Investigator 284, 295, 296, 297
Invincible 290
Iphigenia 28, 290
Iris 285, 286
Ironduke 289
Iroquois 293
Isabella 24, 29
Isis 292, 306

Jamaica 315
Jaseur 297, 299, 301
Jasner 294
Jasper 296
Java 301
Junior 300
Juno 299, 315
Jupiter 297, 300, 302

Karrakutta 291
Kent 317, 318
Kilgarvan 309
Kingfisher 304, 316
King George V. 313
Kinross 287
Kybfels 305

Laburnum 311, 312
Lady Franklin 294
Lancaster 287
Landrail 286, 300, 317
Lark 286, 296
Larne 296
Laurentic 286, 289, 294
Lavender 313
Leander 283, 300, 304, 310, 318

Lee 294, 306
Liffey 292
Lightning 296, 300, 301
Lily 302
Linnet 287, 292, 304
Lively 310
Lizard 284
Locust 295
Lord Salisbury 313
Lowestoft 291
Lucia 292, 312, 314
Lucifer 298

M. 16. 285
M. 21. 315
M. 28. 314
M. 30. 311
M.H. 43. 309
M.L. 53. 309
Madagascar 307
Magnificent 290
Magpie 287, 288, 306, 317
Maidstone 309, 311
Majestic 295, 302
Malabar 288
Malaya 308
Maria Soane 302, 318
Marigold 288
Mastiff 296, 315
Medea 285, 302, 303, 310
Medina 305
Medusa 284, 287
Megaera 289, 299, 301, 315
Melampson 304
Menai 294
Mercedes 310
Merlin 288, 293, 302
Mersey 318
Mild 290
Milford 284
Minerva 29
Modest 295
Monarch 284, 286, 288, 304
Montezuma 317
Monterel 310
Mowhawk 296
Mutine 306, 316
Myosotis 293
Myrmidon 286, 289, 297, 300, 302, 303, 315, 316
Mystic 314

Nassau 287, 288, 289, 299, 303, 306, 308
Nautilus 299
Nelson 301, 310, 314
Nerbudda 286, 296
Nicolas 307
Niger 292
Nile 286
Nimble 283
Northampton 291, 296, 307
Nottingham 304
Nymph 300

Ocean 289
Olympia 314
Ophir 290
Orestes 299, 315
Oriol 313
Orlando 304
Orwell 311
Osmonde 313

Palinuris 306
Paluma 296, 302, 308, 316
Pandora 284
Pantaloon 295
Partridge 287
Pearl 289, 302
Pegasus 284, 302
Pelagonium 311
Pelican 286
Penelope 302, 311
Penguin 303, 308
Perseus 285
Persian 302
Pert 289
Pertongee Bonnenger 285
Pheasant 291
Phaeton 301
Philomel 288, 297
Phoebe 313, 314
Phoenix 284, 285, 303, 306, 314
Pike 317
Pioneer 290, 291
Plover 297, 302
Pluto 295, 297, 298, 300, 301, 305
Polanne 298
Polaris 315
Politania 294
Polynnia 289
Pomone 291

Porcupine 308
Powerful 302
President 296, 318
Prince Albert 306
Prince George 299, 304
Prince of Wales 284
Prince Regent 294
Princess Alberta 307
Princess Royal 303
Prometheus 295, 305
Proserpine 292
Protector 295
Pungo 301
Pylades 284, 288, 305

Quadrille 311
Queen 310
Querida 304

Racoon 315
Raglan 289
Raleigh 305
Rambler 289, 295, 300, 308
Ramilles 287
Ranger 283, 301, 315
Rattler 317
Rattlesnake 286, 304, 306
Raven 283, 297, 306
Rayavet 284
Ready 286
Recruit 286, 316
Renown 286
Repulse 284, 288, 291, 299, 305
Research 303, 304, 305
Rescue 30
Resistance 285, 294, 299, 300, 306
Resolute 299, 303
Retone 300
Retribution 284
Revenge 290, 299, 309, 314
Renard 283
Reynard 302
Rhadamanthus 283, 294, 295, 298, 301, 304
Richard 285
Rifleman 286, 288, 289, 300, 302, 305, 307
Ringarooma 292
River Fisher 313
River St. Lawrence 295, 296
River Tees 313, 314
Riviera 293
Rupert 291
Robert E. Lee 289
Rochester 311
Rodney 299, 307, 309, 315
Rosamund 284, 298, 301
Rosario 302
Rosemary 312
Rowena 314
Roxburgh 290
Royalist 298, 300, 315
Royal Oak 290, 299, 302, 305
Ruby 307
Russell 306
Ruthenia 317

Sable 314
Sabo 309
St. George 292, 309
St. Hiliary 291
St. Vincent 310
Salamander 296, 298, 300, 302
Salamis 290
Samarang 298
Sandhurst 295, 311
Sanspareil 298
Sappho 286, 291, 302
Sardonyx 312, 314
Satellite 296, 297, 298
Scorpion 303
Scourge 299
Scout 306, 317
Scylla 292, 297, 299, 305
Sea Flower 295
Seagull 301
Sealark 289, 291, 296
Seamew 316
Serapis 295, 300
Serpent 298
Severn 307
Shannon 297, 305
Shark 293
Shearwater 289, 297, 298, 318
Shelldrake 292, 297
Silene 293
Silvia 317
Skate 312
Skipjack 283, 290
Skylark 303
Slieve Foy 314
Snake 296, 305
Snap 294, 298
Somersetshire 302

Southampton 316
Southern Cross 301
Spanker 304
Sparrow 312
Sparrowhawk 286, 308
Speedy 303
Sphinx 285
Spiteful 299
Spitfire 287, 297, 298
Spy 302
Stag 300
Stalk 312
Star 301
Steadfast 309
Stern 302
Stonecrop 307
Stonewall 311
Stork 283, 288, 297, 305, 308
Stromboli 300
Styx 295, 296
Sub. E.10. 309
Sub. E.24. 310
Sub. E.29. 313
Sub. E.43. 310
Sub. G.8. 313
Sub. G.13. 292
Sub. J.4. 313
Sub. L.22. 311
Sub. L.27. 311
Sub. M.11. 312
Sub. R.4. 312
Sub. V.3. 312
Sulphur 300
Sunfish 292
Supply 288, 295, 299, 305
Sussex 309
Sutley 299
Sweetbriar 310
Swift 299, 317
Swiftsure 289, 301
Sydney 299, 300, 301, 302
Sylvia 287, 290, 308

Talavra 294
Tamar 287, 288, 289, 299, 302, 305
Tartar 304, 305, 307
Tartarus 287, 296, 300
Tay & Tyne 290
Temeraire 289
Terpsichore 291, 305, 308
Terrible 297, 303
Terror 285, 302, 303, 308
Tervani 314
Teutonic 290
Theseus 288, 315
Thetis 283, 287, 292, 307
Thistle 302
Thrush 284, 301
Thunder 298, 300, 301, 302, 303, 304, 305
Thunderer 285, 296, 301
Tiger 287, 288, 301
Tigress 311
Titania 312, 314
Topaz 29
Torch 306, 307, 316
Torpedo Boat No. 21. 287
Torpedo Boat No. 22. 290, 316
Torpedo Boat No. 28. 303
Torpedo Boat No. 62. 292
Torpedo Boat No. 88. 293
Tourmaline 285, 292, 307, 315
Trafalgar 300, 301, 308
Tribune 296, 305
Trident 288, 300, 317
Triton 291, 297, 302, 306, 316, 317
Triumph 307
Truro 290
Turquoise 286
Tyne 285, 288, 289, 300, 307, 309, 315
Tyrian 288
Tyrolia 317

Undaunted 297, 307
Urgent 285, 286, 293, 303
Usk 311

Venerable 290
Verbena 295
Verdun 313
Vernon 296, 300
Veronica 288, 308, 309
Vestal 285, 286
Vesuvius 302
Viceroy 313
Victor Emanuel 283, 285, 286, 287, 288, 289, 295, 297, 301, 302, 303, 304, 307, 316, 318
Victoria 301, 303
Victorian 307
Victorious 285
Victory 31
Vidette 314
Vindictive 286, 292, 304

Viper 285
Virago 289, 301
Vixen 305, 318
Volage 286, 295, 301, 302, 318
Volcano 298, 317
Vulcan 292, 311
Vulture 288, 294, 315

Wallaroo 305
Wallpole 312
Wanderer 287, 303
War Bahadua 317
Warspite 284, 288, 291, 297, 301, 313
Warwick 311
Wasp 283, 287, 299, 300, 307, 316
Waterloo 285, 286, 287, 300, 301, 302, 304, 306
Waterwitch 298, 308
Westcott 313
Westward Ho 291
Widgeon 295, 301, 306
Wilberforce 286
Wild Swan 291
Winchester 297
Wolfhound 293
Woodlark 294
Woolverine 288, 299
Woolwich 310, 311, 312, 313, 314
Wye 299, 306

York 312

Zebra 295
Zephyr 283

GENERAL INDEX

Excluding the Names of Ships and the Numbering on the mechanisms.

Numbers in bold type indicate the number of the page on which a Plate is to be found.

Adams, F. B. & Sons, 166
Addis, William, 10, 11.
AD Fmss, 142.
AD Fmsz, 99, 100, 142, 207.
Airy, George Biddell, 42, 43, 46, 79, 83, 85, 91, 133, 135, 140-141.
Airy's Remontoir, 85, 86.
Andrews, A.S., 178.
Aneroid Barometer, 99.
Antiquarian Horology, 21, 105.
Apprenticeships,
Miles, Arthur F., 173.
Moss, Joseph W., 173.
Arlington Court, 142.
Arnold, Chas. Frodsham, 78.
Arnold, Frodsham & Co., Liverpool, 7, 79.
Arnold, John Roger, 12, 78, 84, 102-103.
Asprey, 87.
Baffin Bay, 24, 25, 31.
Baillie, G. B., 10.
Baker, 17, 19, 20.
Baker, Edward, 20.
Balance,
Bimetallic Cross-bar, 149.
Charles Frodsham, 116.
Charles Mill Frodsham, 151, 152, **380, 281.**
Double, 87, **371.**
Frodsham-Arnold, 80-82, 84, **369.**
Hartnup-Frodsham, 82, **369, 370.**
Inverted, 90, 91.
Parkinson & Frodsham, 43, 44, **349.**
Uncompensated, 88-92.
William James Frodsham, 44-47, **350.**
Winnerl, 80-82, **369.**
Balance Spring, 92, 93, 116.
Double, 208, **416.**
Duo-in-uno, 118.
Gilt Metal, 93.
Hardening, 86.
Ball, Martin, 103.
Barber, Mary, 11.
Barlow, 42.
Barossa Place, 77.
Barraud, Paul Philip, 102, 103.
Barrel,
Floating, 206, **413.**
Hanging, 206, **413.**
Basle Fair, 189.
Beamont, William, 1.
Beaufort, Capt. F., 42, 83.
Belville, Elizabeth Ruth Naomi, 70, 71, 75.
Belville, John Henry, 70.
Belville, Maria Elizabeth, 69, 70.
Bernoulli, Daniel, 86.
Berthoud, Louis, 80, 86.
Best, Robert, 12.
Black Book, 1, 2, 65.
Blackwood's Magazine, 96, 97.
Blue Mills (Turret Clock), 115, **400.**
Blunt, John, 23.
Board of Longitude, 12.
Bomb Damage, 74, 175, **361.**
Bond Papers, 37.
Bond, W. C., 35, 37.
Bonniksen, B., 213, 314, **427-430.**
Booklets,
Charles Frodsham, 93-96, 96-98, 99, 104, 107-110, 118.
Parkinson & Frodsham, 24, 30, 34-35, 37-41.
Bowerbank v. Frodsham, 50.
Breaking of Mainsprings, 69.
Breguet, 117, 181, 182, 211, 212, **394, 422.**
Breguet Ship's Bell Carriage Clock, 189.
Breguet's Synchroniser, 165, 181.
Bridgeman, Richard, 206..
British Horological Institute, 115.
British Watch & Clock Making Co., 21.

Brockbank, Miles, 12.
Brompton Road (No. 173), 177, 184, 186, 194, **408-410.**
Buckingham Palace, 169, 179.
Budge Row (No. 5), 71-73, **361.**
Bulkhead Clock, 142.
Burnett, Robert, 105, 106.
Burtin, J., 213, **426, 427.**
Business Premises, 242, 243.

Calibre, New, 100-104.
Cambridge Observatory, U.S.A., 132.
Camera Timing Cyclometer Clock, 190, **399.**
Capt. Henry, 198, 204.
Capt. Jules, 198, 200, 205.
Car Clocks, 203.
Carriage Clocks, 141, 142, **401-405, 434.**
Carrington, R. F. & R. W., 21.
Carter, Thomas, 19.
Cecil Coffee House, 78.
Cecil, Lord Robert, 87.
Chancery, A Fortune in, 146, 147.
Change Alley, 22, 65-71.
Chester, 1, 4.
Chichester, Sir Bruce, 142.
Chippendale, The, 180, **396.**
Chronograph, 208, **415.**
Chronometer Clocks, 173, 265.
Chronometer Records (Greenwich), 283-318.
  Baker, 314, 315.
  Frodsham & Baker, 315, 316.
  Frodsham & Keen, 317.
  Frodsham, Charles, 283-294.
  Frodsham, Charles Mill, 316.
  Frodsham, H., 317.
  Frodsham, J., 317.
  Frodsham, W. E., 317, 318.
  Parkinson & Frodsham, 294-314.
Chronometers
  Change in Rates, 34.
  8-Day, 30.
  Improvements in, 44.
  Numbering, 244, 245.
  Pocket, 30, **353, 354.**
Chronometrical Thermometer, 134.
Clavering, Captain, 28.
Clockmakers' Company Freedoms, 10, 15, 19, 22, 23, 49, 53, 54, 115, 152, 171.
Clock Cases, 178-182, 185.
Clock Manufacture, 178.
Clock-Watch, 208, 209, **355, 417, 419, 420.**
Clocks
  Fan, 168.
  Inclined Plane, 170.
  Sedan, 169, **390.**
  Sunflower, 168.
  Tortoise, 168.
  Upside Down, 169, **390.**
  Various, 179-182, **392-396.**
Clowes, Mollie, 190.
Clowes, Philip Arthur, 175-187, **407.**
Code, Secret, 72.
Cole, James Ferguson, 104-107, 111, 112, 114, **372.**
Cole's Resilient Escapement, 208.
Cole's Spring-tail Resilient Banking, 208, 209.
Cole, The, 180, 181, **394.**
Colley, The, 180, **392.**
Comparative Tables, 327-333.
Complicated Watches, 207, 208.
Cope, Charles, 12.
Cotterell, Thomas, 32, 33.
Cover, Alan Desmond, 192, 194, **410.**
Cover, Arthur, 191, 192, **410.**
Croker, J. W., 25.
Cumming, The, 180, **394.**

Dating Watches, 245-247.
Davis Strait, 24.
Dawson, Percy, 178.
Day of the Month Watch, 103, 104.
Dean Street (No. 80B), Soho, 198.
de Carle, Donald, 170.
Dennison, D. B., 104.
Dent, Edward John, 9, 34, 78, 111.
Dent, E. & Co. Ltd., 191, 218.
Dering Street (No. 17), 169.
Devon Instruments Ltd., 195, 196, **434, 435.**
Dial Plate, 119.
Dixon Charity, 19.
Dixon, Charlotte, 53.
Doberawer's Lamp, 69.
Dolcoath, 80.
Double Balance-spring, 208, **416.**
Double Rotary Escapement, 104-106, **372.**
Douglas, W. H., 215, **432, 433.**

Douzième Gauge, 68.
Ducker, John, 72.
Duke Street (No. 11), 168.
Dundas, Capt., The Hon. Richard, 27.
Duo-in-uno Balance Spring, 116, 118.
Dwerryhouse, John, 12.

Earnshaw, Thomas, 12, 15.
Eiffe, John Sweetman, 44, 45, 90.
Electricity & Magnetism, 66, 67.
Elizabeth, H.R.H. Princess, 179.
Ellicott, The, 181, **395.**
Ellison, J. M., 174, 175.
Emery, The, 181, **395.**
Encyclopaedia Metropolitana, 42.
Escapement
Dead Beat, 116.
Double Rotary, 104-106, **372.**
Gravity, 158.
Lever, 116.
Trochilic, 166, 167.
Two-pin (Turret Clock), 139, 140, 158.
Exhibitions
Crystal Palace (1851), 100-104.
Calcutta (1883), 67.
International Inventions (1885), 20, 167.
Le Havre (1868), 67.
Naples (1871), 159.
Paris (1867), 67, 132.
Paris (1878), 20, 160.
Philadelphia (1876), 159.
Second Great International (1862), 115, 116.
Special Loan, South Kensington (1876), 69, 159.
Expeditions
African, 306.
Antarctic, 293, 296, 299.
Arctic, 285, 286, 295, 302, 306, 308.
Ashante, 295.
Australian Survey, 303.
British Columbia Survey, 284, 316.
Cape Survey, 286.
Eclipse, 284, 299, 303, 308.
Livingstone, 303.
Livingstone Search, 69.
New South Wales, 300.
Niger, 305.
North American Boundary, 286, 299, 302, 303, 306, 308, 318.
North Pole, 27, 28.
North West Passage, 24-27, 31.
Nova Scotia Survey, 308.
Oregon, 300.
Peruvian Survey, 317.
Prince Edward Island Survey, 316.
Queensland Survey, 300.
Sabine's Pendulum Experiments, 28, 29.
South American Survey, 42.
South Australian Survey, 286.
Southern, 296.
Transit of Venus, 285, 286, 289, 290, 291, 306, 308, 315.
Valentia, Longitude, 296, 298, 303, 305.
Van Diemen's Land Survey, 303, 304.
West Coast of England Survey, 286.
West India Survey, 294.
Exports, 37.

Family Bible Destroyed, 148.
Family Trees
Alice Frodsham, 222, 223.
Elton, The Frodshams of, 221.
Edward Frodsham, 228, 239.
George Horsfall Frodsham, 237.
Kingsgate Street, The Frodshams of, 18.
Mary Maria Frodsham, 240, 241.
Simplified Frodsham Tree, 8.
William James Frodsham, 224-235.
Farey, 94.
Fell, Andrew, 184, 186, 187.
Fixed Winder, 208, **412.**
Foster, Captain, 27-29.
Fortune in Chancery, 1, 146-147.
Fowler, Sir John, 159.
Free-Sprung, 30.
French, W. H., 183, 184, 189, 193, 194.
Frodesham Family, 2-6.
Frodsham, Alice, 13-15, 222, 223.
Frodsham & Baker, 17, 19-20.
Frodsham & Keen, 59-61.
Frodsham-Arnold Balance, 80-82.
Frodsham Balance, 116.
Frodsham Bridge, 3.
Frodsham Castle, 2, 6.
Frodsham, Charles, 1, 9, 23, 42, 53, 76-146, 228-231, **373.**
Frodsham, Charles & Co., 158, 166.

Frodsham, Charles & Co. Ltd., 167.
Frodsham, Charles, His family, 150-157, 228-231.
Frodsham, Charles Mill, 115, 145-146, 150-154, **380, 381.**
Frodsham, Charlotte, 53.
Frodsham Church, 2.
Frodsham, Edward, 13, 15, 147, 238-239.
Frodsham, Eliza, 53.
Frodsham, Elizabeth Mill, 53, 77, 150, 155-157.
Frodsham, Emma, 54.
Frodsham Family Bible Destroyed, 148.
Frodsham Family Trees, see 'Family Trees'.
Frodsham, George, 1, 13, 23, 54, 64.
Frodsham, George Edward, 19-21.
Frodsham, George Horsfall, 65, 237.
Frodsham, George William, 54, 65-66, 68-72.
Frodsham, Harrison Mill, 141, 154, 155, 158-171, **382-385.**
Frodsham-Hartnup Balance, 80-82.
Frodsham, Henry, 1, 9, 10, 23, 52, 56-60, **356.**
Frodsham, Henry Herbert, 1, 61-63, **360.**
Frodsham, Henry John, 19.
Frodsham, Herbert, 1, 61.
Frodsham, Hugh Rose Swire, 183.
Frodsham, Hyrum Plumer, 147, 148.
Frodsham, James, 13.
Frodsham, John, 9, 13, 14, 16, 17, 19, 23, 53.
Frodsham, John & Son, 19.
Frodsham, John Mill, 50, 150, 152.
Frodsham, Jonathan, 10.
Frodsham, Mary, 13, 15.
Frodsham, Mary Ann, 54.
Frodsham, Mary Maria, 1, 2, 65, 66, 72, 240, 241.
Frodsham Movement Gauge, 120.
Frodsham Pillar Gauge, 120, 122.
Frodsham's Register, Charles, 325, 326.
Frodsham, Sarah, 13.
Frodsham, Scroll, 6.
Frodsham, Son & Co., 19.
Frodsham Tables, 322-325.
Frodsham, The, 180, **396.**
Frodsham, Thomas, 55.
Frodsham Town, 2.
Frodsham, William (The Elder), 9, 10-14, 16, 22.
Frodsham, William (The Younger), 9, 14-16, 22.
Frodsham, William & Son, 13-14.
Frodsham, William (The Second), 23, 54, 55, 64-65.
Frodsham, William Edward, 23, 52, 55.
Frodsham, William James, 9, 12, 14, 15, 22-56, 64, 76, 224-235, **348.**
Will of, 47-50, 64, 76.
Furneaux, H. J., 168, 170.
Furneaux, J. R., 21, 168, 170.
Fusee, Reversed, 102-103.

Galvanic Apparatus, 133.
Galvanic Chronometer, 159.
Gardner, Malcolm, 175, 183, 184, 186, 187, 193.
Gardner, Mary Maria, 65.
Gauge
Frodsham Movement, 120.
Frodsham Pillar, 120.
Lancashire, 118, 319-321.
Lancashire Pillar, 119.
Watch Glass, **375, 377, 378.**
Vernier Slide, 118.
Gazeley, W. J., 106.
Gould, R. T., 80, 105, 141, 166.
Gould, The, 182, **396.**
Gracechurch Street, 17, 19, 21.
Grant, The, 181, **395.**
Gravity Escapement, 158.
Gray, Benjamin, 111.
Greenwich Chronometer Records, 283-318.
Greenwich Time, 69, 70, 75, 96-99.
Greenwich Trials, 20, 32-34, 52, 53, 76, 266-271.
Arnold & Frodsham, 269.
Charles Frodsham, 266, 267, 270, 271.
Charles Mill Frodsham, 270.
Frodsham & Baker, 269.
Frodsham & Keen, 269.
G. E. Frodsham, 269.
H. Frodsham, 269.
Parkinson & Frodsham, 268, 269, 271.

Greenwich Trials, First Admiralty Premium, 159, 160.
Grimalde & Johnson, 114, 115, 151.

Half-Chronometer, 206.
Hall, James Thomas, 23.
Hall Marks, 245-247.
Hanging Barrel, 206, **413.**
Harris, Geoffrey Charles, 74, 75.
Harris, Lord, 175, 184.
Harris, William Charles Shrubsall, 72-74.
Harrison, John, 12, 13, 15.
Harrison, William, 13.
Hartnup Balance, 82, 87, 90.
Hartnup-Frodsham Balance, 82, 87, 90.
Higham, A. J., 160.
Hodgson, G. S., 173, 177.
Hole, Henry, 17.
Holland, W. & E. A., 214, **431, 433.**
Honours and Awards, 132.
Hopkins, 26.
Hopner, Captain, 27.
Horological Journal, 21, 82, 118, 121, 163-165, 167, 169.
Horse Shoe Yard, 168, 169.
Hutton, John, 161, 162.

Igoolik, 26.
Ilbert, Courtenay, 175, 176, 184, 189.
Impulse Roller, Large, 134-141.
Institution of Civil Engineers, 93, 96, 110.
Inverted Roller, 208.
Isochronism, Laws of, 93-96.

Jamieson, George, 12.
Jauncey, Captain J., 175.
Jefferson, President, 42.
Johnson, William, 114, 115.

Karrusels, 209, 210, 211, 213-215, **427-433.**
Bonniksen, 213, 214, **427-430.**
Douglas, W. H., 215, **432, 433.**
Holland, W. & E. A., 214, **431, 433.**
Keen, Robert John, 59-61.
Kendall, Lieut., 26, 28.
Kermock, W. A., 187, 188.
Kew Certificates, 272-282.
Charles Frodsham, 274-280.
Frodsham & Keen, 282.
G. E. Frodsham, 281.
Parkinson & Frodsham, 281.
King, Captain, 29.
Kingsgate Street, 11, 12, 16, 17, 21.
Kullberg, Victor, 102, 263, 264.
Lambert, Hannah, 22.
Lancashire Gauge, 319-321.
Lancashire Movement Gauge, 118, 119, 122.
Lancashire Pillar Gauge, 119.
Lancaster Sound, 24, 25, 31.
Larard, H., 21.
Large Impulse Roller, 134-141.
Liddon, Lieut., 25.
Litherland, Davies & Co., 92.
Liverpool, 52, 56-61.
Livingstone, Doctor, 69.
Long, S., 111.
Lyon, Captain, 26.

Magneta Time Systems, 172.
Magnetic Experiments, 34.
Main-spring, Breaking of, 69.
Make & Break Contacts, 133, 134.
Mantel Clocks, 141, 142, **403, 435.**
Manufacturers
Charles Frodsham, 255-262.
Parkinson & Frodsham, 248-254.
Mappin & Webb, 184.
Markham, The, 179, **392.**
McCabe, The, 179, **395.**
Melbourne Observatory, 132.
Melville Island, 25, 35.
Melville, Lord, 27.
Mercer, Thomas, 59, 71, 173, 218, 265.
Mercer, Tony, 173, 265.
Mercurial Pendulum, 42, 128-131, **379.**
Micron Instruments, 186, 187.
Middle Temperature Error, 84, 85.
Mill, Elizabeth, 77.
Molyneux, Robert, 26, 44, 45.
Moore, George John, 157, 166.
Morgan, C. M., 177.
Movement Sizes, Clock, 119-122, 182, **397.**
Movement, Striking, 191.
Murray, James, 27.
Murray, The, 181, **394.**

Nautical Magazine, 34, 35, 77, **362, 363.**
Navarino Terrace, 77.
New Bond Street (No. 115), 168, **386.**

Nicole, Adolf, 198.
Nicole & Capt., 198, 205.
Nicole Nielson & Co., 197-203.
Nielson, Sophus Emil, 166, 168, 200, 203.
Night Watchman's Clock, 72, **351, 352.**
North & Sons, 202.
North & Sons, Ltd., 169, 203, 204.
North, Jane Grace, 171, 175.
North Magnetic Pole, 31, **347.**
North, Robert Benson, 171-176, **407.**
North West Passage, 24, 26, 31, **347.**
North, William James, 172-176.

Observatories
Allegeny, U.S.A., 159.
Cambridge, U.S.A., 132.
Greenwich, 133.
Melbourne, 132.
Omdurman, 159.
Ormerod, George, 1.
Outil aux Douzièmes, 68.

Pamphlet, Spanish, 107-110.
Parkinson & Frodsham, 9, 16, 22-51, 57, 64-75.
Parkinson & Frodsham Booklets, 24, 30.
Parkinson & Frodsham, Liverpool, 56.
Parkinson, William, 9, 14, 16, 22, 47.
Parry, William Edward, 24-27, 31, 35.
Patents
Bonniksen, B. (No. 21,421), 213, **428.**
Burtin, J. (No. 7880), 213, **426.**
Douglas, W. H. (No. 6858), 215, **432.**
Frodsham, Harrison Mill (No. 191), 162, **382-384.**
Frodsham, Harrison Mill (No. 2912), 161.
Furneaux, H. J. (No. 4189), 170, **391.**
Higham, A. J. (No. 2917), 160.
Holland, W. & E. A. (No. 20,235), 214, **431.**
Hutton, J. (No. 11427), 160.
Nicole, Adolf (No. 905), 199.
Nicole, Adolf (No. 1461), 199.
Nicole, Adolf (No. 10,348), 198.
Nielson, S.E. (No. 13,366), 200.
North, R. B. (No. 6737), 202, **425.**
Taylor, A. (No. 16, 623), 212, **423.**
Pavement (Nos. 7 & 12), 77.
Peckover, The, 181, **396.**
Pendulum
Dead-beat, 132.
Mercurial, 42, 128-131.
Vibration of, 37-42.
Pennington, John, 92.
Perpetual Calendar, 207, 209, **414, 419, 420.**
Phillips, Monsieur, 117.
Pillar Plate Sizes, 119-122.
Pillar Sizes, 119, 120, 127.
Poole, John, 45, 62.
Potter, M. V., 173, 177.
Prices, 20.
Prince Regent Inlet, 27, 31.
Princess, The, 179, **396.**
Princess Striking Movement, 191.

Quare, The, 182, **396.**
Queen Victoria Street (No. 16), 71.
Quick Trains, 42, 79.
Quill, Colonel H., 1, 15.

Rebuilt by Frodsham, 82, 83.
Red Lion Square, 11, **345.**
Regulators, 142.
Remontoires, 163-165.
Restored by Frodsham, 82, 83, 101, 149.
Reversed Fusee, 30, 102, 103, 207, 208.
Revue Chronomique, 82.
Rock, W., 169, 170.
Ross, James Clark, 24, 31.
Ross, John, 24, 31.
Royal Appointment, 111, 173.
Royal Exchange (Nos. 35 & 15B), 71.
Russell, Thomas Robert, 61.
Rusting of Blued Steel, 92.
Rutherford, A. F., 168-171, **407.**

Sabine, Captain Edward, 24, 25, 28, 35.
Secret Code, 72.
Sedan, The, 180, **390.**
Ship's Bell Carriage Clock, 189.
Ship's Bell Clock, 188, 189, **398.**
Ship's Clock, 142.

Sizes, Movement
French, 122.
Frodsham, 120-122.
Lancashire, 119, 122.
Wycherley, 120-122.
Sizes, Pillar
French, 127.
Frodsham, 120.
Lancashire, 119.
Sizes, Watch Glass, 123-126, 327-333, **375, 377, 378.**
Slide Rule, 118.
Smith, Samuel, 202.
Soho Square (No. 14), 198, 200.
South Audley Street (No. 45), 195.
South Molton Street (No. 27), 170.
Spanish Pamphlet, 107-110, 193.
Speedometers, 169, 202, 203, **387, 388.**
Split Centre Second's-Hand Watch, 325, 326.
Steelyard, 118.
Stokes, Captain, 29.
Strand Improvement Scheme, 78.
Strand (No. 84), 78, 168, **366, 367.**

Tables
Comparative Watch Glass, 124, 327-333.
Corresponding Sizes of English Watches, 117.
Timing Watches & Chronometers, 127, 324.
Trains, 112, 113.
Various, 322-324.
Taylor, A., 212, **423, 425.**
Telford Medal, 93-96.
Thirkell, Frank, 70, 183, 184, 190, 194, **410.**
Thornton, Philip, 180, 181, 184, 185.
TIM, 70.
Time of Flight, 207, **421.**
Tompion, The, 180, **392, 393.**
Tourbillons, 201, 209-213, **419, 420, 422-427.**
Breguet, 211, 212, **422.**
Burtin, J., 213, **426, 427.**
North, R. B., 212, **424, 425.**
Taylor, A., 212, **423, 425.**
Trade Sign, 188, **406.**
Transit of Venus (1874), 151.
Tregent, The, 179, **392.**
Trochilic Escapement, 166, 167.
Tuning Fork Banking, 208.
Turret Clocks, 115, 116, **400.**
St. Mark's, Victoria Park, 159.
Tytherleigh, Susan Cockett, 152, 153, 154.

Unclaimed Frodsham Property, 147.
Uncompensated Balances, 88-92.
Universal Adjusting Rod, 118.
Uplyme, 54, 55, 64.
Upper Bedford Place (No. 26), 110.

Valencia, 30.
Vibrations of Pendulums, 37-41.
Viennese, The, 179, **396.**
Virginia, College of, 42.
Vulliamy, Benjamin Lewis, 66, 94, 107, 110, 111.
Vulliamy, Hugh Francis, 66.
Vulliamy, Justin, 10, 11.
Vulliamy Work Bench, 190.

Washington, U.S.A., 46.
Watch
Centre-Seconds, **416.**
Day of the Month, 103, 104.
Eight-day, 207, **412.**
Floating Barrel, 206, **413.**
Full Plate, 207, **411.**
Half-Chronometer, 206.
Hanging Barrel, 206, **413.**
In a Ring, 73, 74.
Independent Centre Seconds, 207. **411.**
Manufacture, 21, 185.
Minute Repeating, 207, 208, 209, **414, 417, 419-420.**
Perpetual Calendar, 207, 209, **414, 419, 420.**
Reversed Fusee, 207, 208, **413, 416.**
Split Centre Second's-Hand, 104, 325, 326.
Spring Detent, 207, **411, 412.**
Time of Flight, 207, **421.**
Watch Glass Sizes, 123-126, 327-333, **375, 377, 378.**
Watch Manufacture, 21, 185.
Watch Movement Sizes, 119-122.
Watford Speedometers, 169, 202, 203.
Webster, Richard, 32, 33.

Weld, C. R., 132.
Willard & Son, 115.
Willcocks, Richard, 17.
Wills
Charles Frodsham, 143-145.
Elizabeth Frodsham, 155-157.
William Frodsham (The Elder), 13-15.
William James Frodsham, 47-50, 64.
Winnerl Balance, 82.
Winter Island, 26.
Workmens' Addresses, 58.
Wrist Watch, 186.
Wycherley, John, 120.
Yule, Gladys M., 176, 183, 186, 190, 191.

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The Society, which was formed in 1953 and now has a world-wide membership, exists to further the study of the history of time measurement in all its forms. To achieve this, the Society holds regular lecture meetings and arranges visits to horological collections; it also produces a quarterly journal *Antiquarian Horology* and various other publications.

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